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Tokunaga et al.

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(54) **METHOD OF MANAGING VIRTUAL COMPUTER, COMPUTER SYSTEM AND COMPUTER**

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(73) Assignee: **Hitachi, Ltd.**, Tokyo (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 101 days.

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PCT Pub. Date: **Jun. 21, 2012**

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(51) **Int. Cl.**

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G06F 21/30	(2013.01)
G06F 21/62	(2013.01)
G06F 21/44	(2013.01)

(52) **U.S. Cl.**
CPC ***G06F 21/30*** (2013.01); ***G06F 21/44*** (2013.01); ***G06F 21/62*** (2013.01)

(58) **Field of Classification Search**
None
See application file for complete search history.

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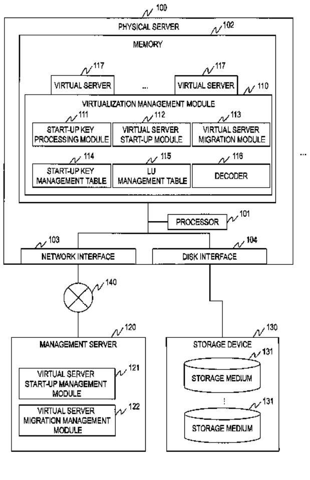
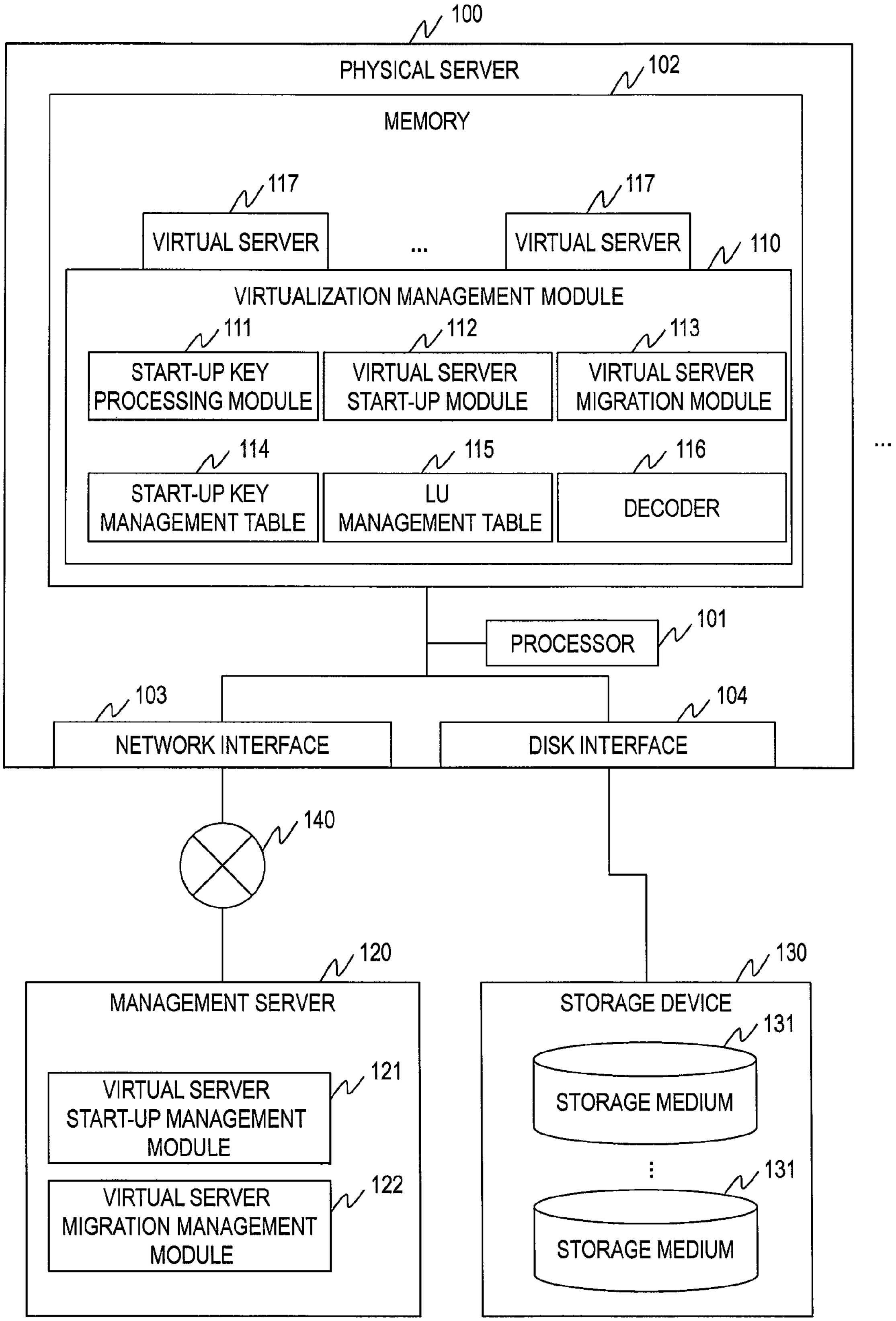
(57) **ABSTRACT**

A method of managing a virtual computer in a computer system including a plurality of computers, each of the computer storing a program for realizing a virtualization management module for managing a virtual computer, including a management storage area that is accessible only by the virtualization management module, storing start-up management information representing a correspondence among identification information on the virtual computer, identification information on a logical storage area storing a service program, and start-up authentication information for starting the virtual computer. The method including: a step of referring to the start-up management information to determine whether the start-up authentication information corresponding to the virtual computer exists, in a case of receiving a start-up request; a step of reading the service program from the logical storage area and executing the read service program, in a case of being determined the start-up authentication information exists.

19 Claims, 23 Drawing Sheets

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PHYSICAL SERVER
102
MEMORY
117
VIRTUAL SERVER
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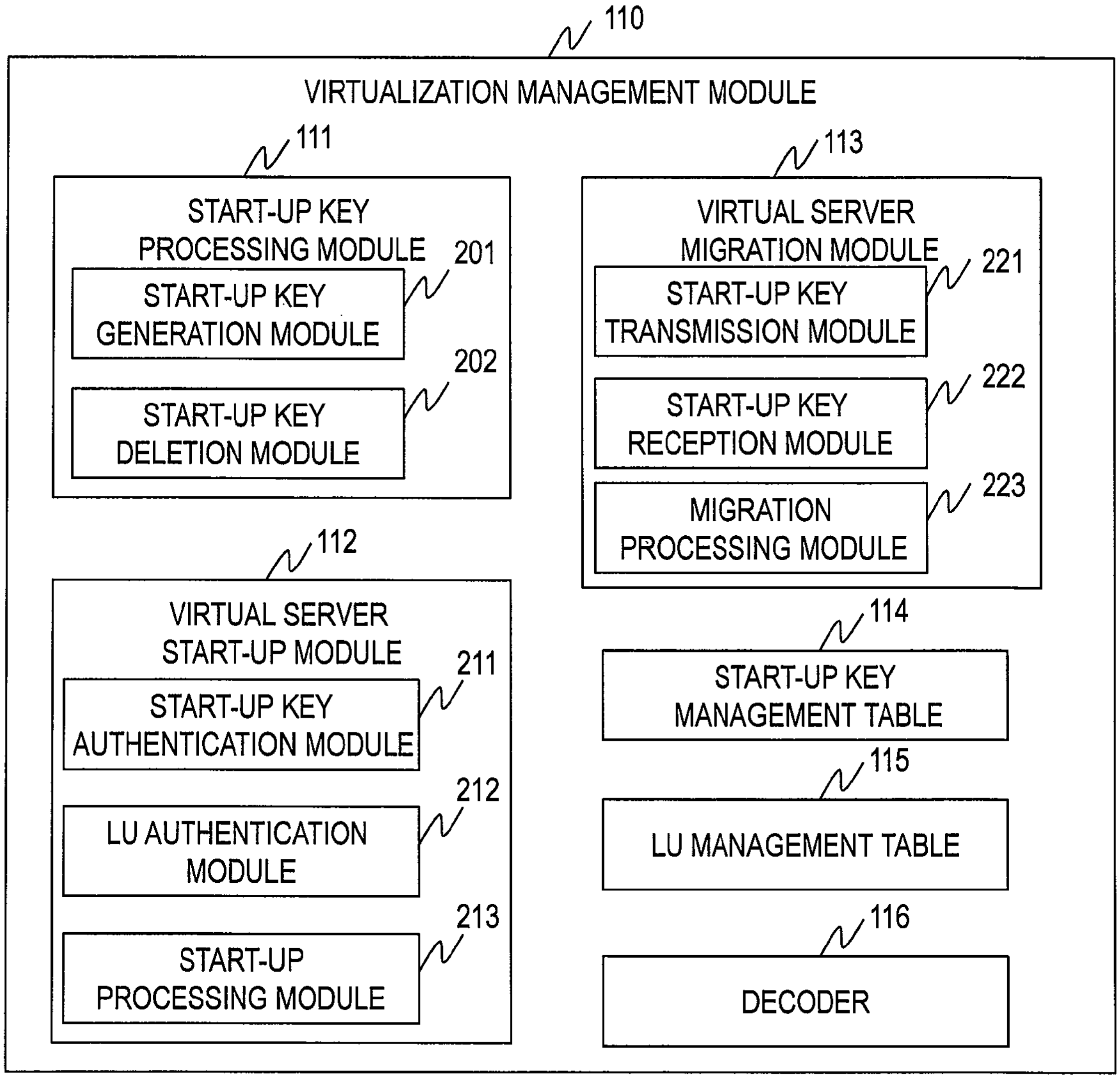
117
VIRTUAL SERVER
110
VIRTUALIZATION MANAGEMENT MODULE
111
START-UP KEY PROCESSING MODULE
112
VIRTUAL SERVER START-UP MODULE
113
VIRTUAL SERVER MIGRATION MODULE
114
START-UP KEY MANAGEMENT TABLE
115
LU MANAGEMENT TABLE
116
DECODER
...
PROCESSOR
101
103
NETWORK INTERFACE
104
DISK INTERFACE
140
120
MANAGEMENT SERVER
121
VIRTUAL SERVER START-UP MANAGEMENT MODULE
122
VIRTUAL SERVER MIGRATION MANAGEMENT MODULE
130
STORAGE DEVICE
131
STORAGE MEDIUM
⋮
131
STORAGE MEDIUM

Fig. 1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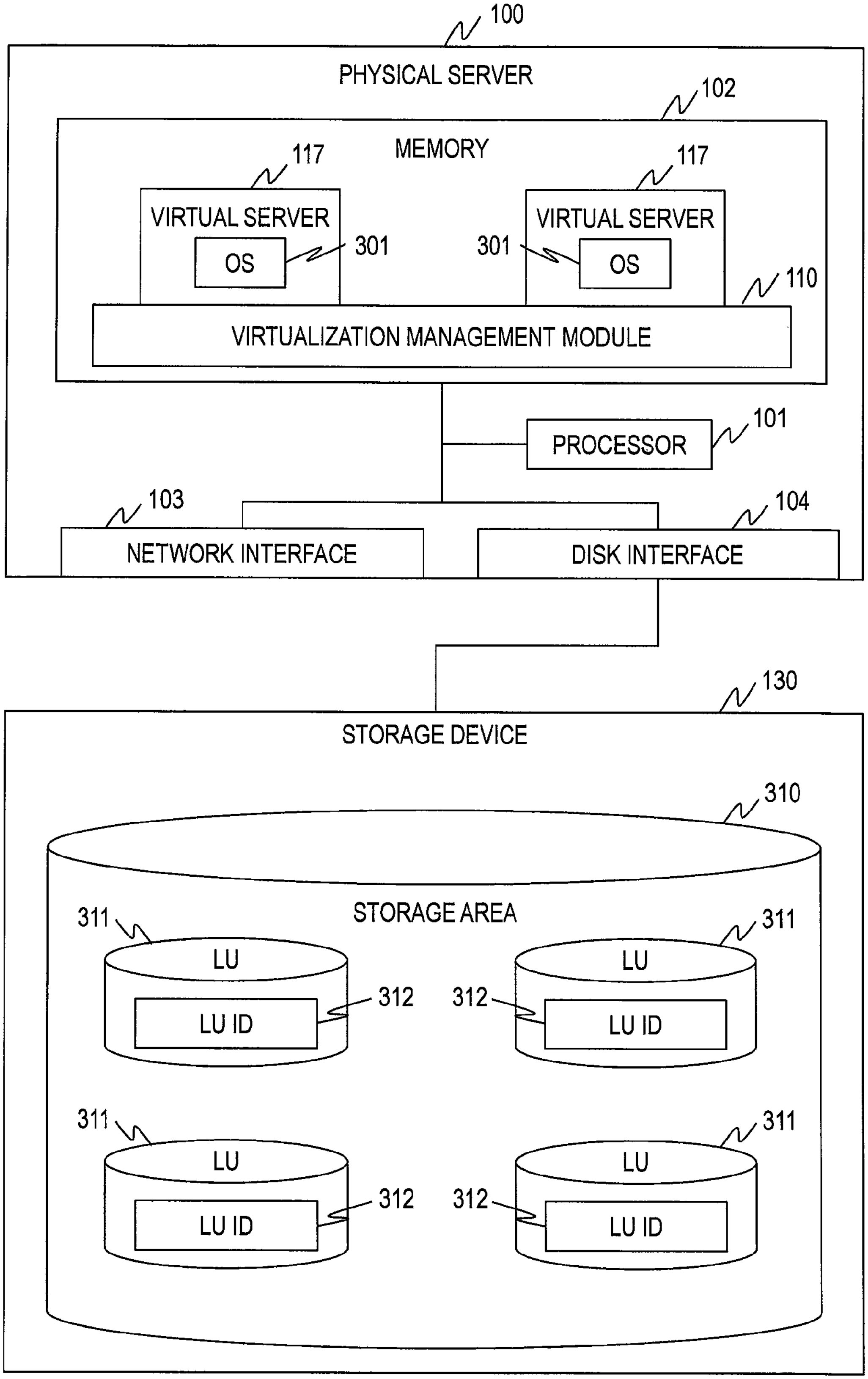
VIRTUALIZATION MANAGEMENT MODULE
111
START-UP KEY PROCESSING MODULE
201
START-UP KEY GENERATION MODULE
202
START-UP KEY DELETION MODULE
113
VIRTUAL SERVER MIGRATION MODULE
221
START-UP KEY TRANSMISSION MODULE
222
START-UP KEY RECEPTION MODULE
223
MIGRATION PROCESSING MODULE
112
VIRTUAL SERVER START-UP MODULE
211
START-UP KEY AUTHENTICATION MODULE
212
LU AUTHENTICATION MODULE
213
START-UP PROCESSING MODULE
114
START-UP KEY MANAGEMENT TABLE
115
LU MANAGEMENT TABLE
116
DECODER

Fig. 2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VIRTUAL SERVER
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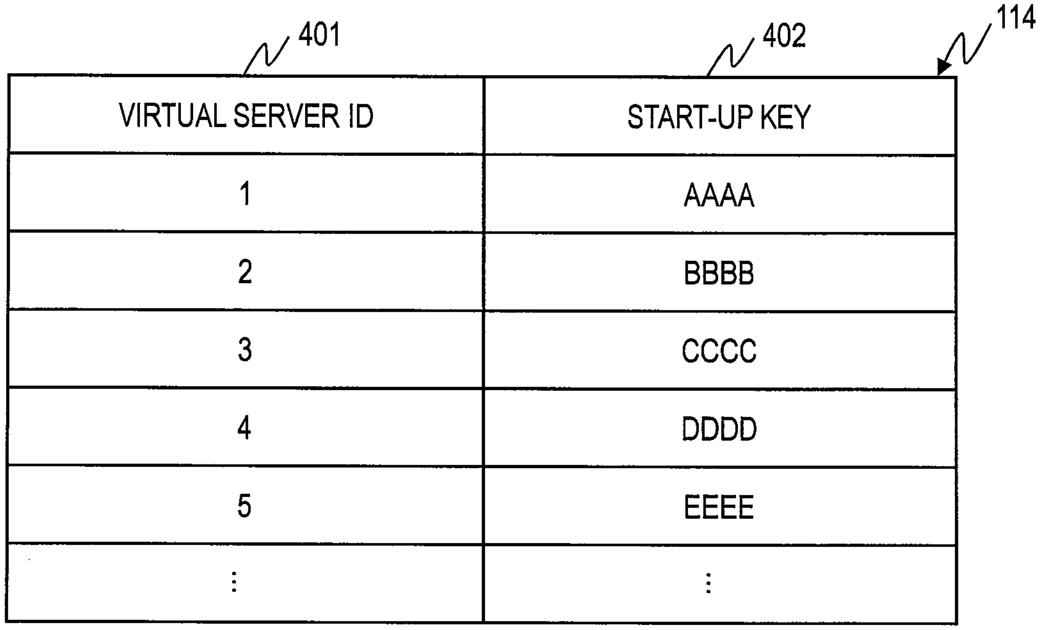
PROCESSOR
101
103
104
NETWORK INTERFACE
DISK INTERFACE
130
STORAGE DEVICE
310
STORAGE AREA
311
311
LU
LU
LU ID
312
312
LU ID
311
311
LU
LU
LU ID
312
312
LU ID

Fig. 3

START-UP KEY MANAGEMENT TABLE



VIRTUAL SERVER ID	START-UP KEY
1	AAAA
2	BBBB
3	CCCC
4	DDDD
5	EEEE
⋮	⋮

Fig. 4

LU MANAGEMENT TABLE

501 502 115

VIRTUAL SERVER ID	LUID
1	LU01
2	LU02
3	LU03
4	LU04
5	LU05
⋮	⋮

Fig. 5

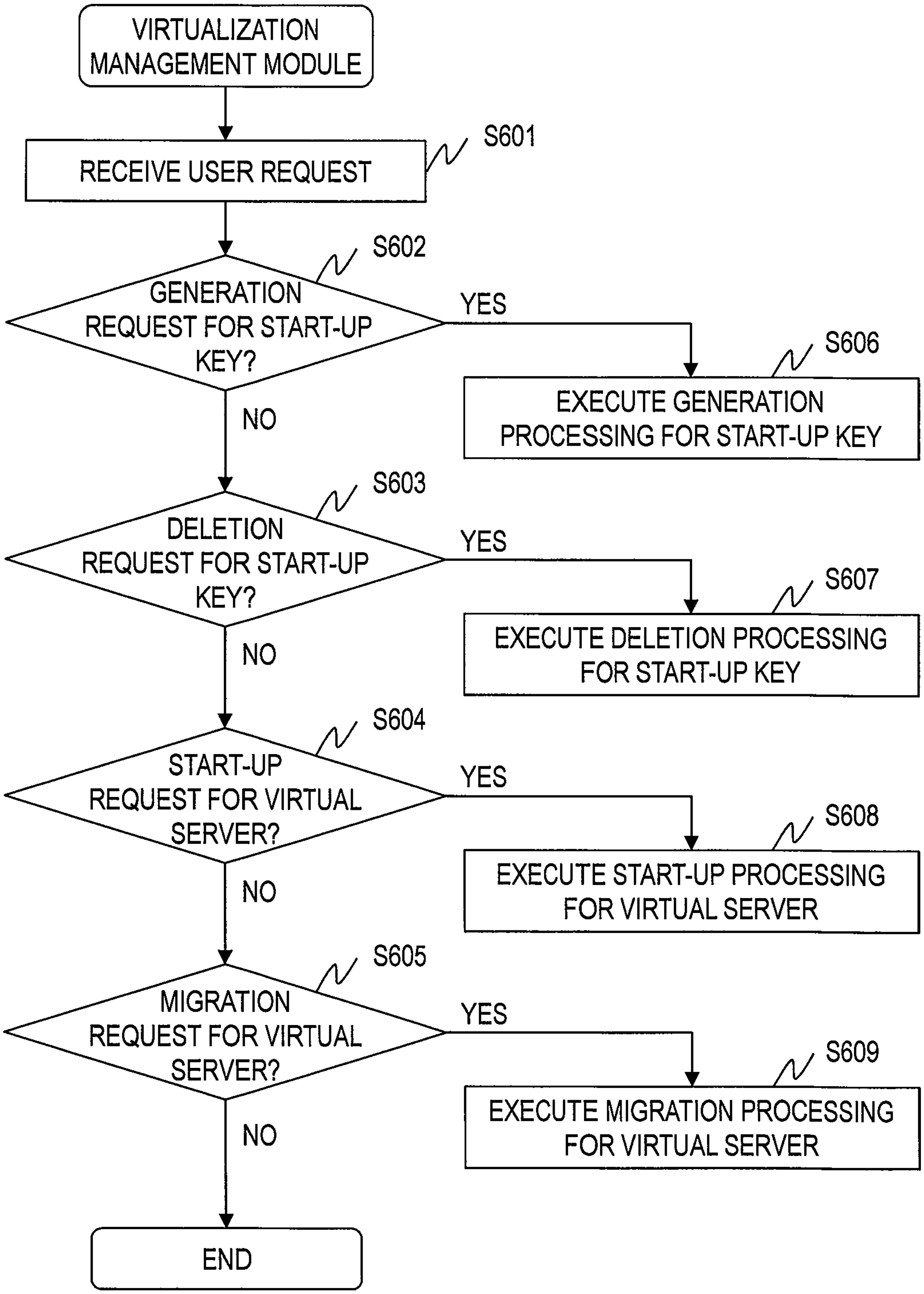

VIRTUALIZATION MANAGEMENT MODULE
RECEIVE USER REQUEST
S601
GENERATION REQUEST FOR START-UP KEY?
S602
YES
NO
EXECUTE GENERATION PROCESSING FOR START-UP KEY
S606
DELETION REQUEST FOR START-UP KEY?
S603
YES
NO
EXECUTE DELETION PROCESSING FOR START-UP KEY
S607
START-UP REQUEST FOR VIRTUAL SERVER?
S604
YES
NO
EXECUTE START-UP PROCESSING FOR VIRTUAL SERVER
S608
MIGRATION REQUEST FOR VIRTUAL SERVER?
S605
YES
NO
EXECUTE MIGRATION PROCESSING FOR VIRTUAL SERVER
S609
END

Fig. 6

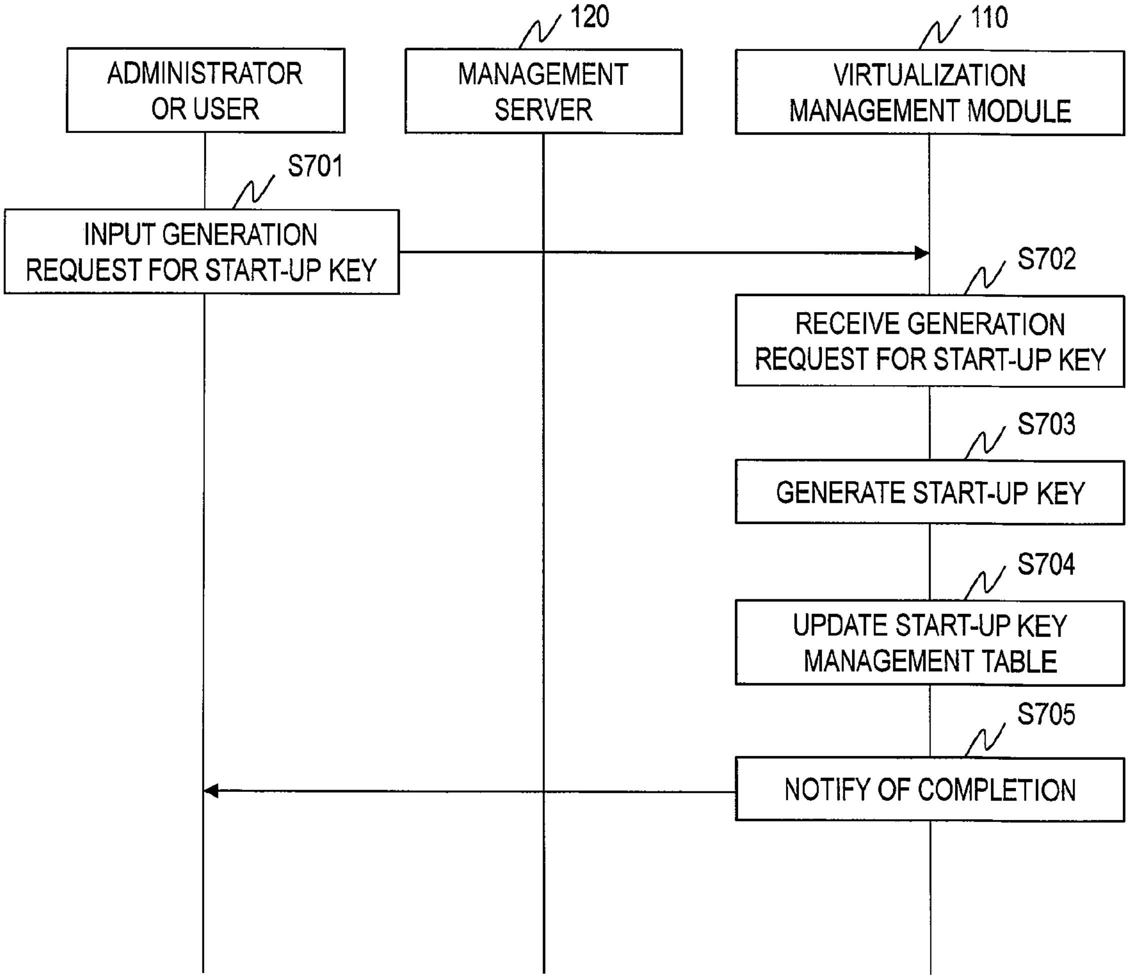

120
110
ADMINISTRATOR OR USER
MANAGEMENT SERVER
VIRTUALIZATION MANAGEMENT MODULE
S701
INPUT GENERATION REQUEST FOR START-UP KEY
S702
RECEIVE GENERATION REQUEST FOR START-UP KEY
S703
GENERATE START-UP KEY
S704
UPDATE START-UP KEY MANAGEMENT TABLE
S705
NOTIFY OF COMPLETION

Fig. 7

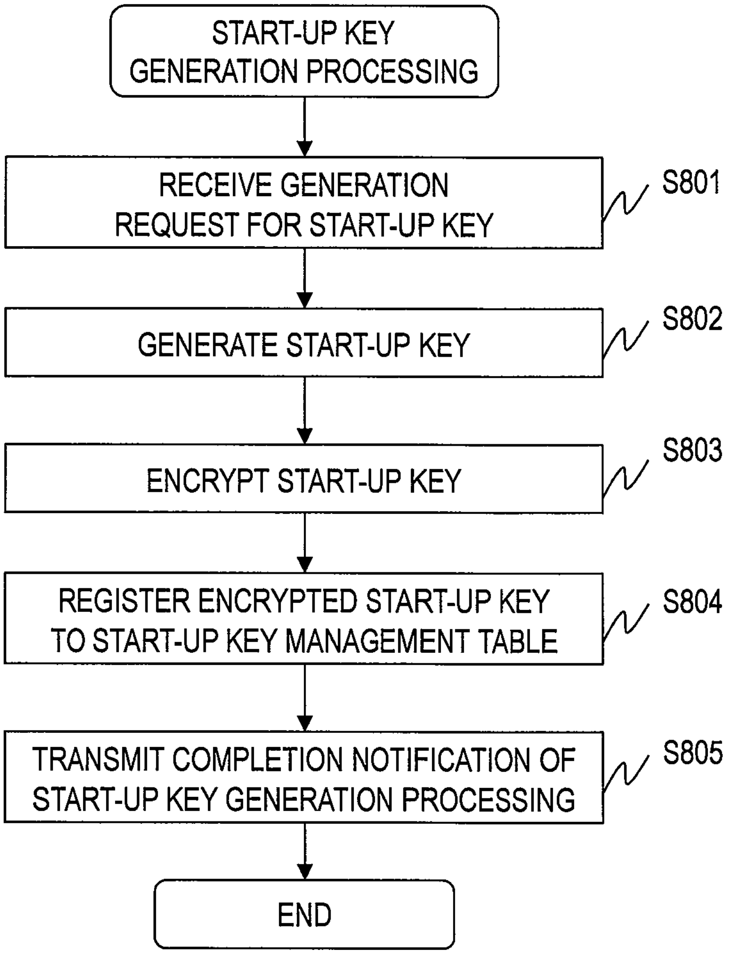

START-UP KEY GENERATION PROCESSING
RECEIVE GENERATION REQUEST FOR START-UP KEY
S801
GENERATE START-UP KEY
S802
ENCRYPT START-UP KEY
S803
REGISTER ENCRYPTED START-UP KEY TO START-UP KEY MANAGEMENT TABLE
S804
TRANSMIT COMPLETION NOTIFICATION OF START-UP KEY GENERATION PROCESSING
S805
END

Fig. 8

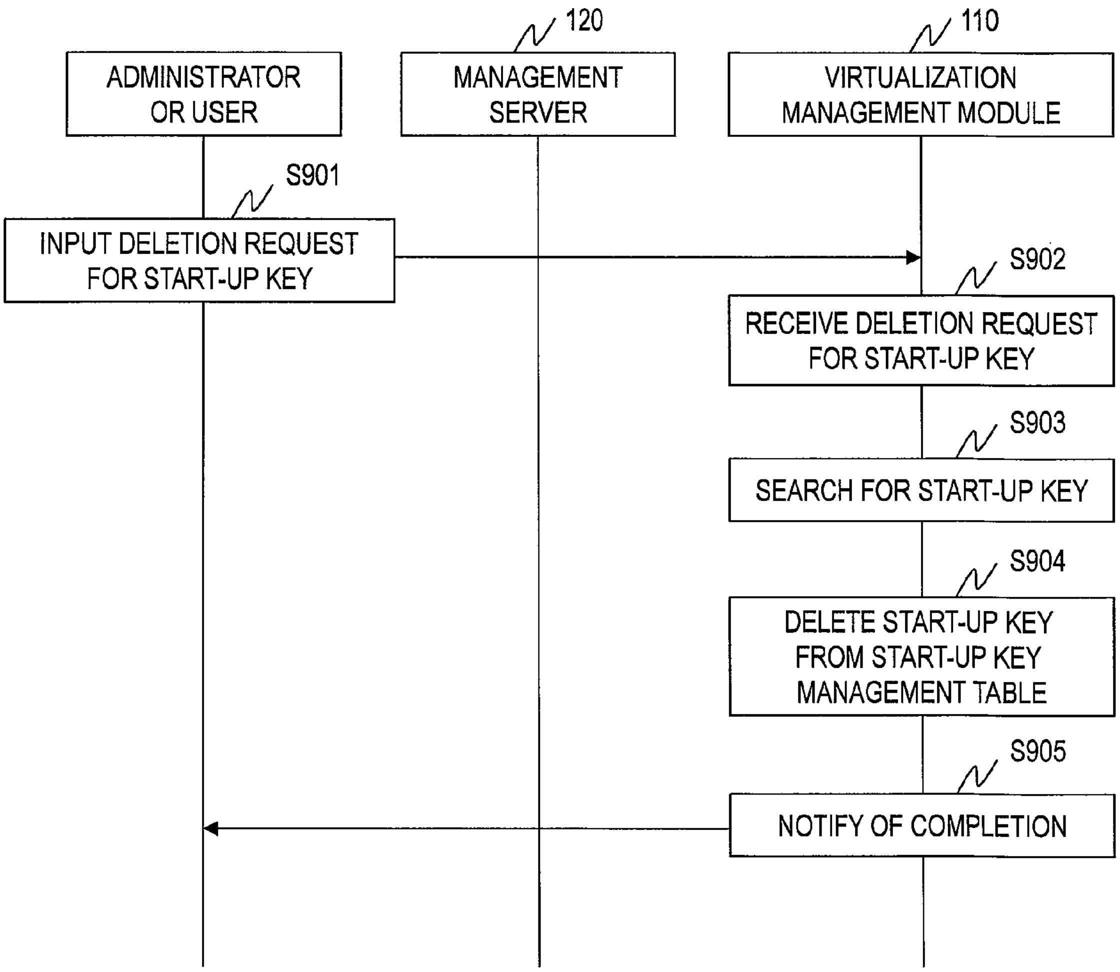

120
110
ADMINISTRATOR OR USER
MANAGEMENT SERVER
VIRTUALIZATION MANAGEMENT MODULE
S901
INPUT DELETION REQUEST FOR START-UP KEY
S902
RECEIVE DELETION REQUEST FOR START-UP KEY
S903
SEARCH FOR START-UP KEY
S904
DELETE START-UP KEY FROM START-UP KEY MANAGEMENT TABLE
S905
NOTIFY OF COMPLETION

Fig. 9

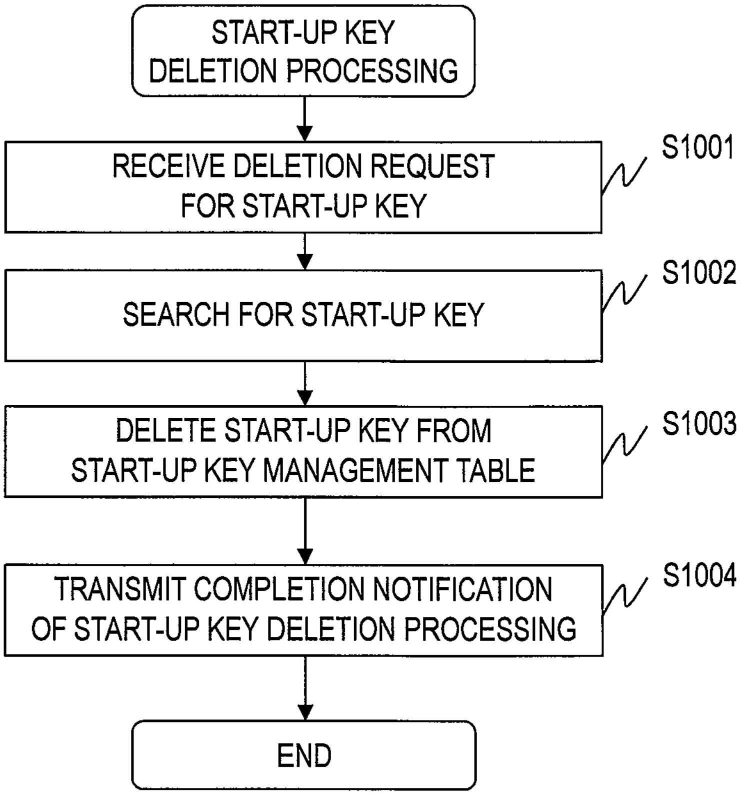

START-UP KEY DELETION PROCESSING
RECEIVE DELETION REQUEST FOR START-UP KEY
S1001
SEARCH FOR START-UP KEY
S1002
DELETE START-UP KEY FROM START-UP KEY MANAGEMENT TABLE
S1003
TRANSMIT COMPLETION NOTIFICATION OF START-UP KEY DELETION PROCESSING
S1004
END

Fig. 10

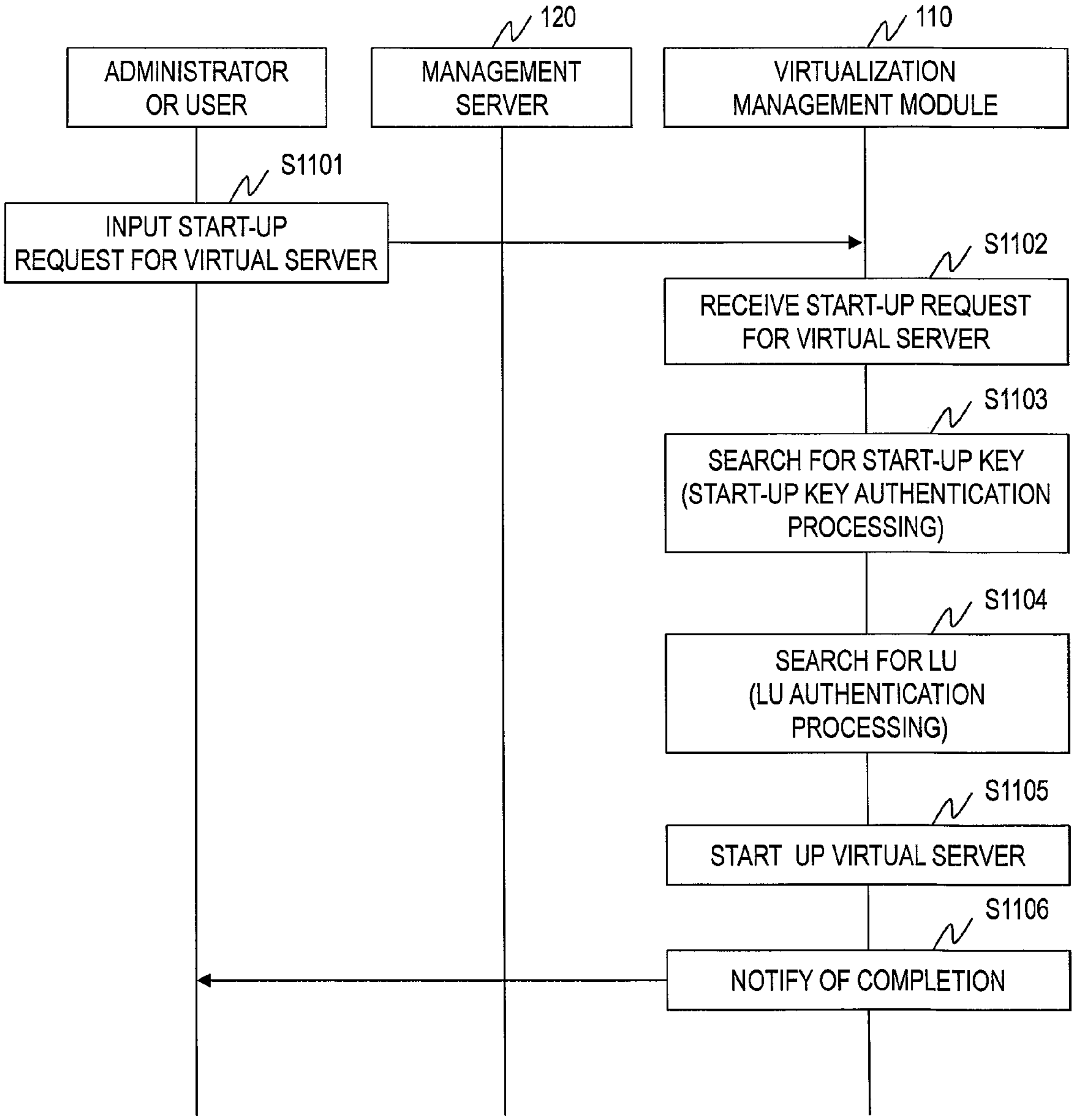

120
110
ADMINISTRATOR OR USER
MANAGEMENT SERVER
VIRTUALIZATION MANAGEMENT MODULE
S1101
INPUT START-UP REQUEST FOR VIRTUAL SERVER
S1102
RECEIVE START-UP REQUEST FOR VIRTUAL SERVER
S1103
SEARCH FOR START-UP KEY (START-UP KEY AUTHENTICATION PROCESSING)
S1104
SEARCH FOR LU (LU AUTHENTICATION PROCESSING)
S1105
START UP VIRTUAL SERVER
S1106
NOTIFY OF COMPLETION

Fig. 11A

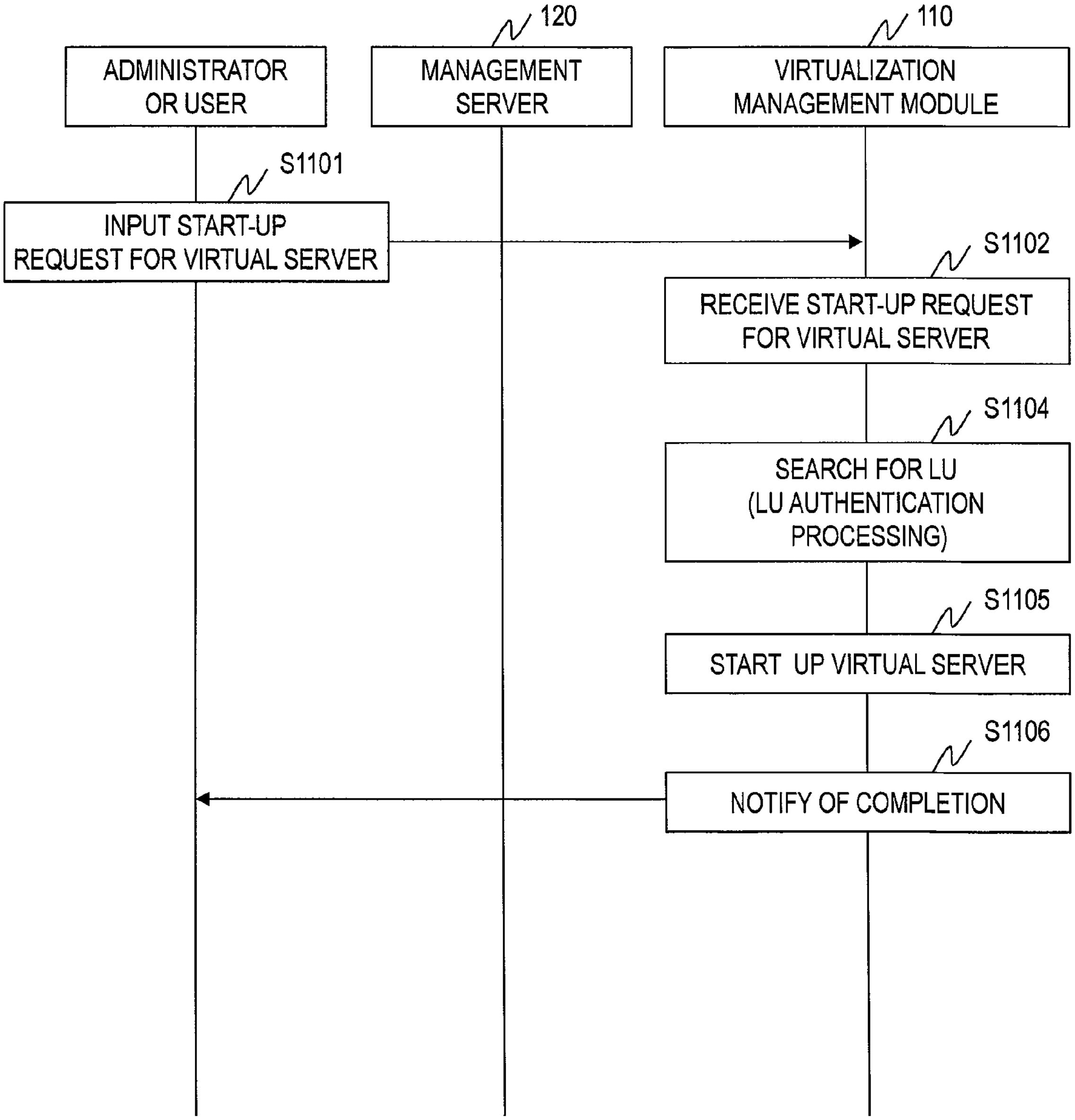

120
110
ADMINISTRATOR OR USER
MANAGEMENT SERVER
VIRTUALIZATION MANAGEMENT MODULE
S1101
INPUT START-UP REQUEST FOR VIRTUAL SERVER
S1102
RECEIVE START-UP REQUEST FOR VIRTUAL SERVER
S1104
SEARCH FOR LU (LU AUTHENTICATION PROCESSING)
S1105
START UP VIRTUAL SERVER
S1106
NOTIFY OF COMPLETION

Fig. 11B

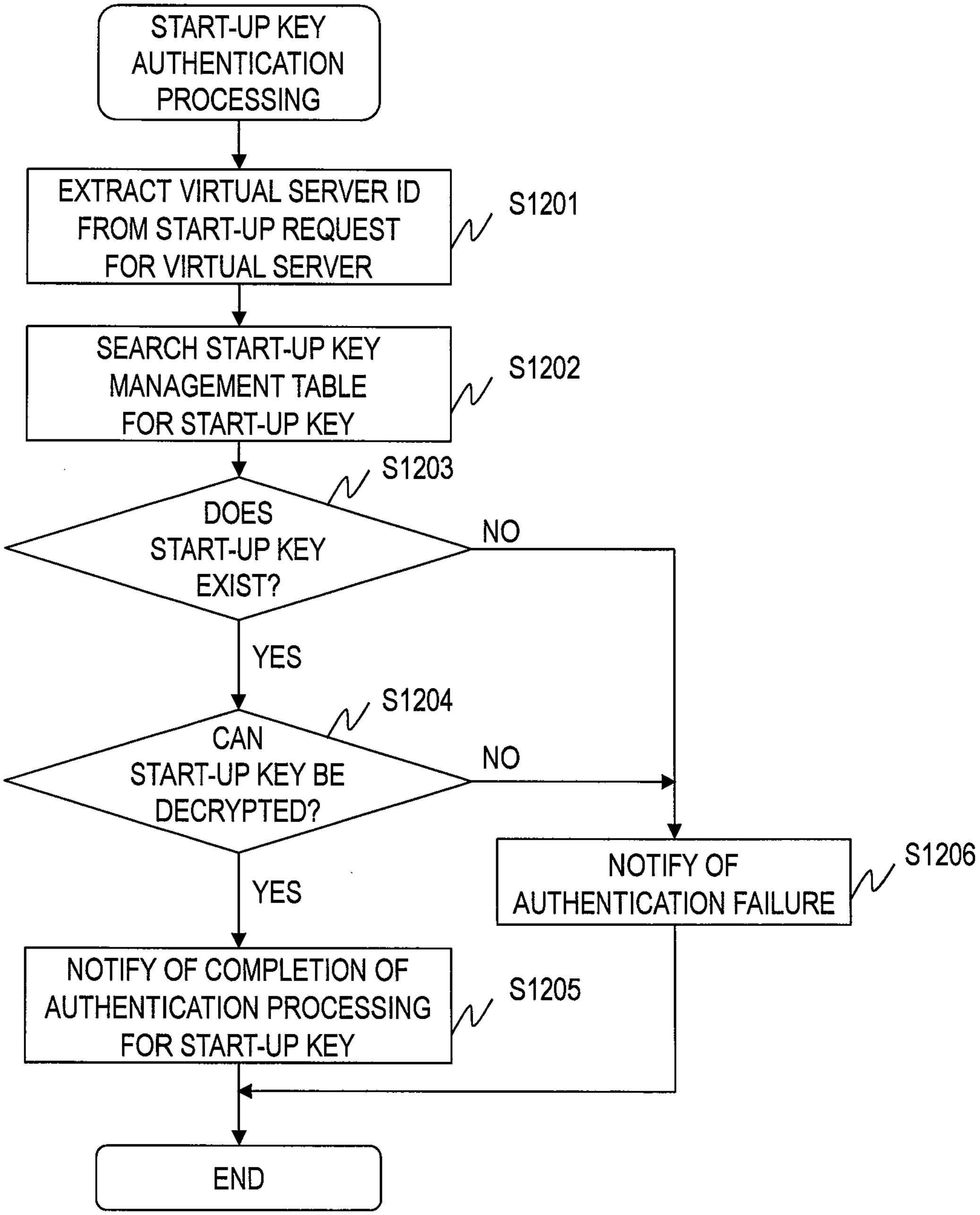

START-UP KEY AUTHENTICATION PROCESSING
EXTRACT VIRTUAL SERVER ID FROM START-UP REQUEST FOR VIRTUAL SERVER
S1201
SEARCH START-UP KEY MANAGEMENT TABLE FOR START-UP KEY
S1202
S1203
DOES START-UP KEY EXIST?
NO
YES
S1204
CAN START-UP KEY BE DECRYPTED?
NO
YES
NOTIFY OF AUTHENTICATION FAILURE
S1206
NOTIFY OF COMPLETION OF AUTHENTICATION PROCESSING FOR START-UP KEY
S1205
END

Fig. 12

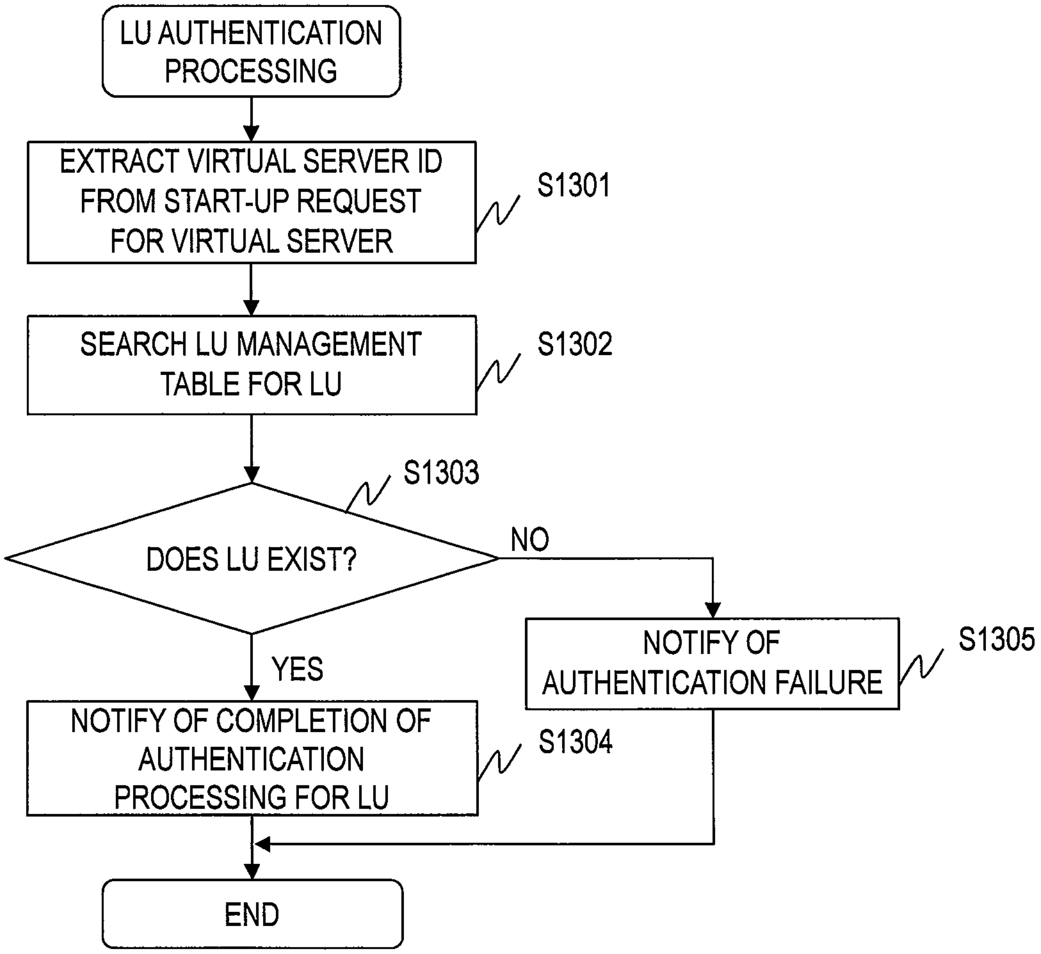

LU AUTHENTICATION PROCESSING
EXTRACT VIRTUAL SERVER ID FROM START-UP REQUEST FOR VIRTUAL SERVER
S1301
SEARCH LU MANAGEMENT TABLE FOR LU
S1302
S1303
DOES LU EXIST?
NO
NOTIFY OF AUTHENTICATION FAILURE
S1305
YES
NOTIFY OF COMPLETION OF AUTHENTICATION PROCESSING FOR LU
S1304
END

Fig. 13

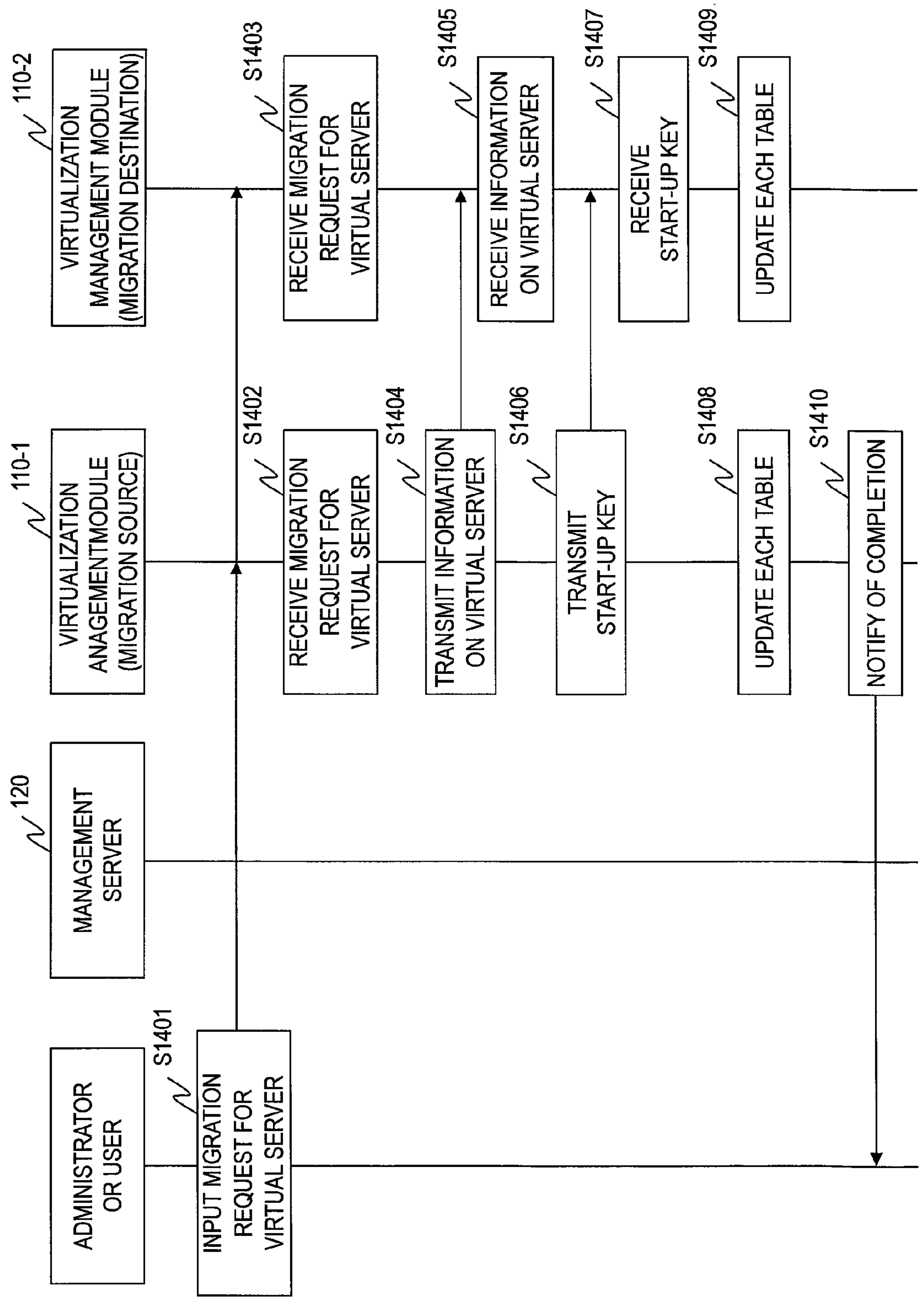

ADMINISTRATOR OR USER
120
MANAGEMENT SERVER
110-1
VIRTUALIZATION ANAGEMENTMODULE (MIGRATION SOURCE)
110-2
VIRTUALIZATION MANAGEMENT MODULE (MIGRATION DESTINATION)
S1401
INPUT MIGRATION REQUEST FOR VIRTUAL SERVER
S1402
RECEIVE MIGRATION REQUEST FOR VIRTUAL SERVER
S1403
RECEIVE MIGRATION REQUEST FOR VIRTUAL SERVER
S1404
TRANSMIT INFORMATION ON VIRTUAL SERVER
S1405
RECEIVE INFORMATION ON VIRTUAL SERVER
S1406
TRANSMIT START-UP KEY
S1407
RECEIVE START-UP KEY
S1408
UPDATE EACH TABLE
S1409
UPDATE EACH TABLE
S1410
NOTIFY OF COMPLETION

Fig. 14

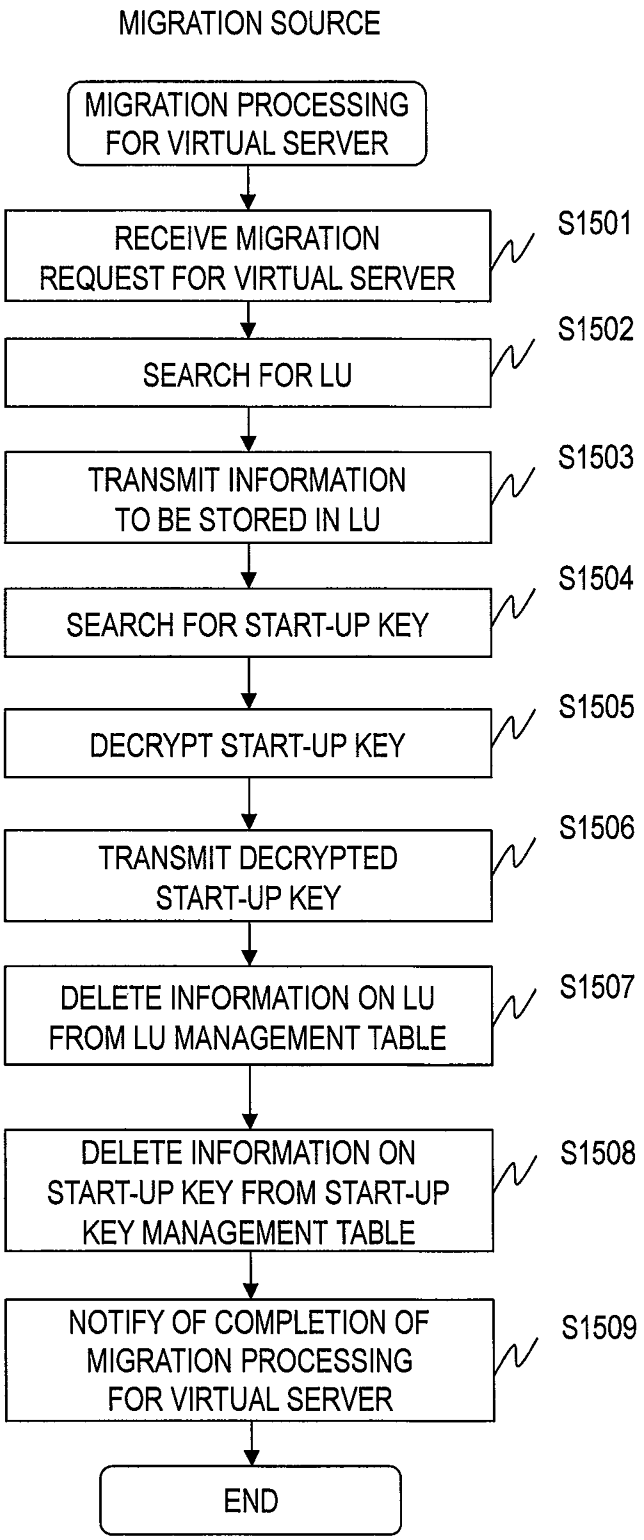

MIGRATION SOURCE
MIGRATION PROCESSING FOR VIRTUAL SERVER
RECEIVE MIGRATION REQUEST FOR VIRTUAL SERVER
S1501
SEARCH FOR LU
S1502
TRANSMIT INFORMATION TO BE STORED IN LU
S1503
SEARCH FOR START-UP KEY
S1504
DECRYPT START-UP KEY
S1505
TRANSMIT DECRYPTED START-UP KEY
S1506
DELETE INFORMATION ON LU FROM LU MANAGEMENT TABLE
S1507
DELETE INFORMATION ON START-UP KEY FROM START-UP KEY MANAGEMENT TABLE
S1508
NOTIFY OF COMPLETION OF MIGRATION PROCESSING FOR VIRTUAL SERVER
S1509
END

Fig. 15

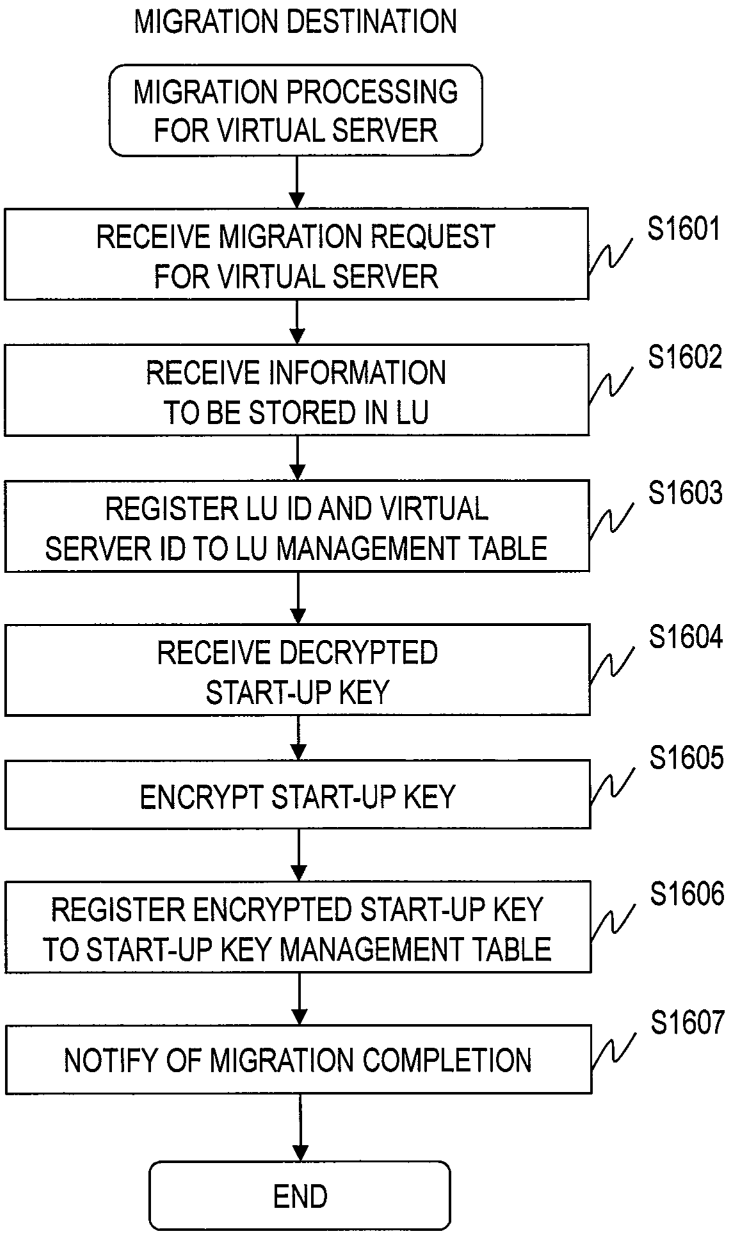

MIGRATION DESTINATION
MIGRATION PROCESSING FOR VIRTUAL SERVER
RECEIVE MIGRATION REQUEST FOR VIRTUAL SERVER
S1601
RECEIVE INFORMATION TO BE STORED IN LU
S1602
REGISTER LU ID AND VIRTUAL SERVER ID TO LU MANAGEMENT TABLE
S1603
RECEIVE DECRYPTED START-UP KEY
S1604
ENCRYPT START-UP KEY
S1605
REGISTER ENCRYPTED START-UP KEY TO START-UP KEY MANAGEMENT TABLE
S1606
NOTIFY OF MIGRATION COMPLETION
S1607
END

Fig. 16

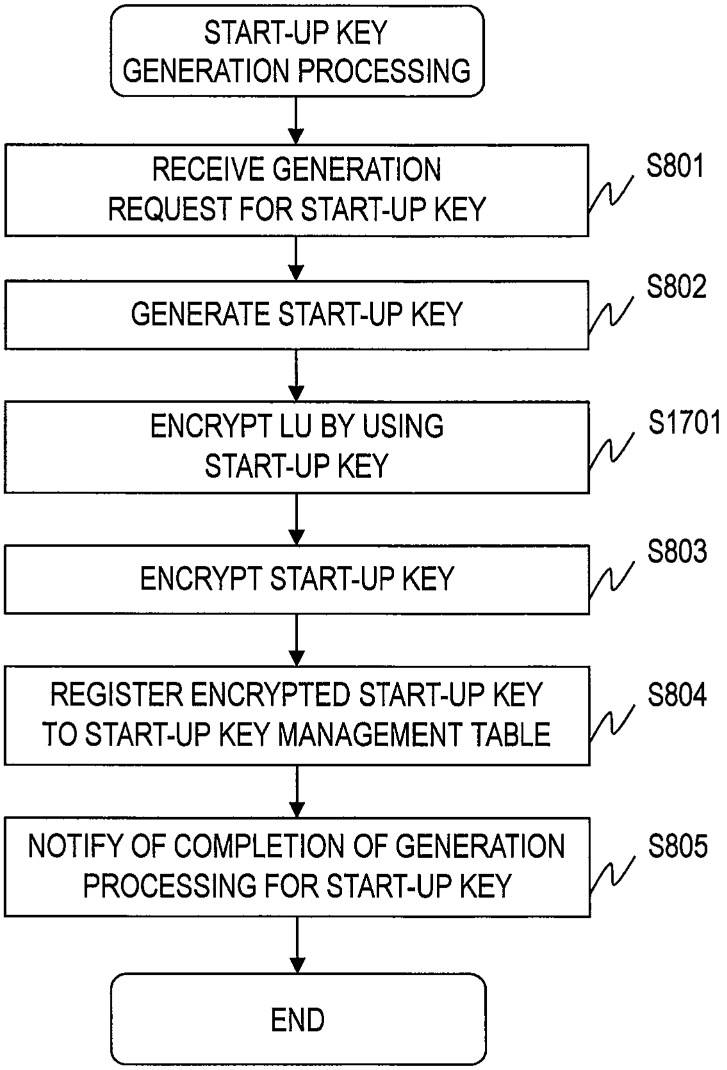

START-UP KEY GENERATION PROCESSING
RECEIVE GENERATION REQUEST FOR START-UP KEY
S801
GENERATE START-UP KEY
S802
ENCRYPT LU BY USING START-UP KEY
S1701
ENCRYPT START-UP KEY
S803
REGISTER ENCRYPTED START-UP KEY TO START-UP KEY MANAGEMENT TABLE
S804
NOTIFY OF COMPLETION OF GENERATION PROCESSING FOR START-UP KEY
S805
END

Fig. 17

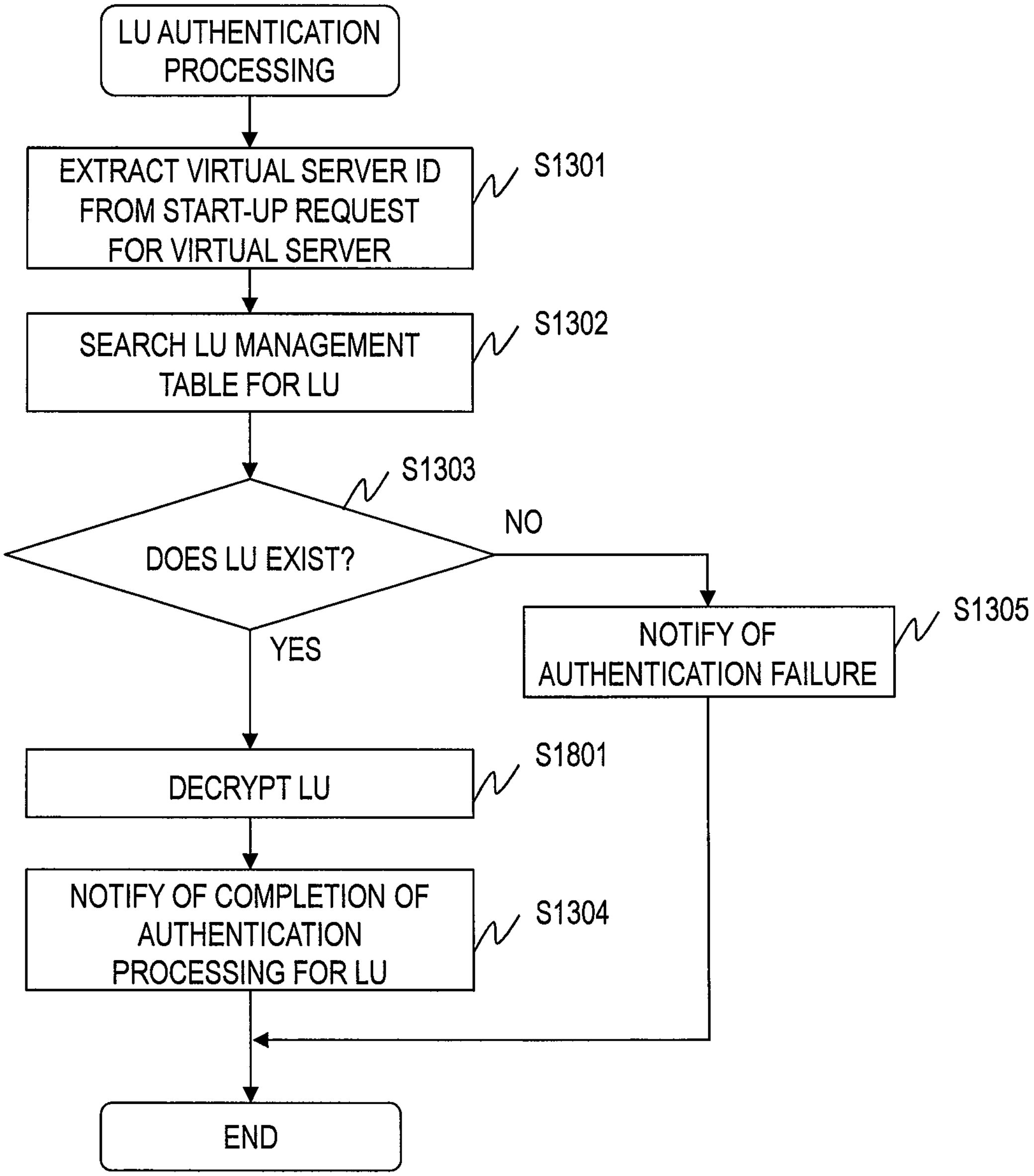

LU AUTHENTICATION PROCESSING
EXTRACT VIRTUAL SERVER ID FROM START-UP REQUEST FOR VIRTUAL SERVER
S1301
SEARCH LU MANAGEMENT TABLE FOR LU
S1302
S1303
DOES LU EXIST?
NO
YES
NOTIFY OF AUTHENTICATION FAILURE
S1305
DECRYPT LU
S1801
NOTIFY OF COMPLETION OF AUTHENTICATION PROCESSING FOR LU
S1304
END

Fig. 18

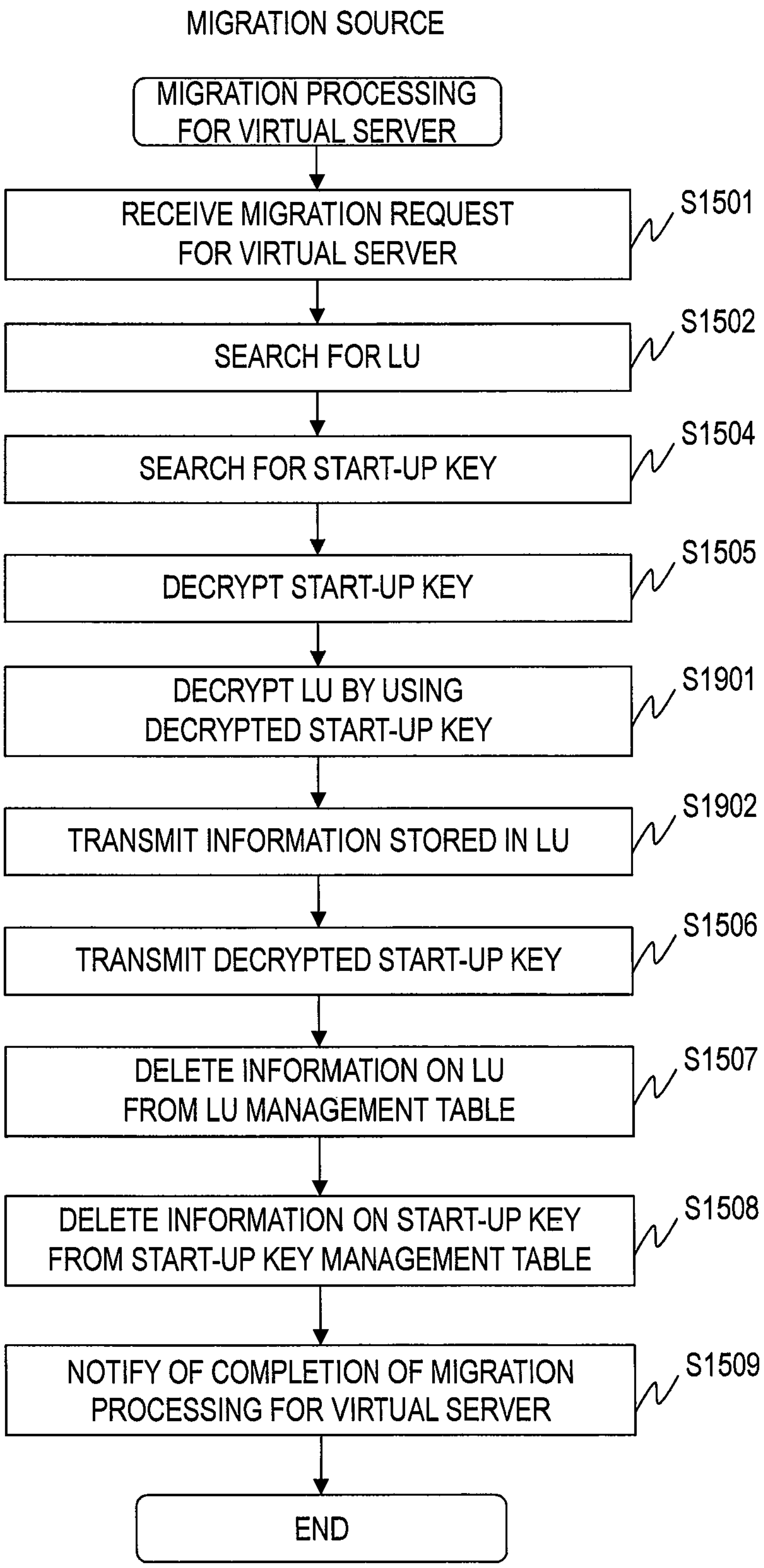

MIGRATION SOURCE
MIGRATION PROCESSING FOR VIRTUAL SERVER
RECEIVE MIGRATION REQUEST FOR VIRTUAL SERVER
S1501
SEARCH FOR LU
S1502
SEARCH FOR START-UP KEY
S1504
DECRYPT START-UP KEY
S1505
DECRYPT LU BY USING DECRYPTED START-UP KEY
S1901
TRANSMIT INFORMATION STORED IN LU
S1902
TRANSMIT DECRYPTED START-UP KEY
S1506
DELETE INFORMATION ON LU FROM LU MANAGEMENT TABLE
S1507
DELETE INFORMATION ON START-UP KEY FROM START-UP KEY MANAGEMENT TABLE
S1508
NOTIFY OF COMPLETION OF MIGRATION PROCESSING FOR VIRTUAL SERVER
S1509
END

Fig. 19

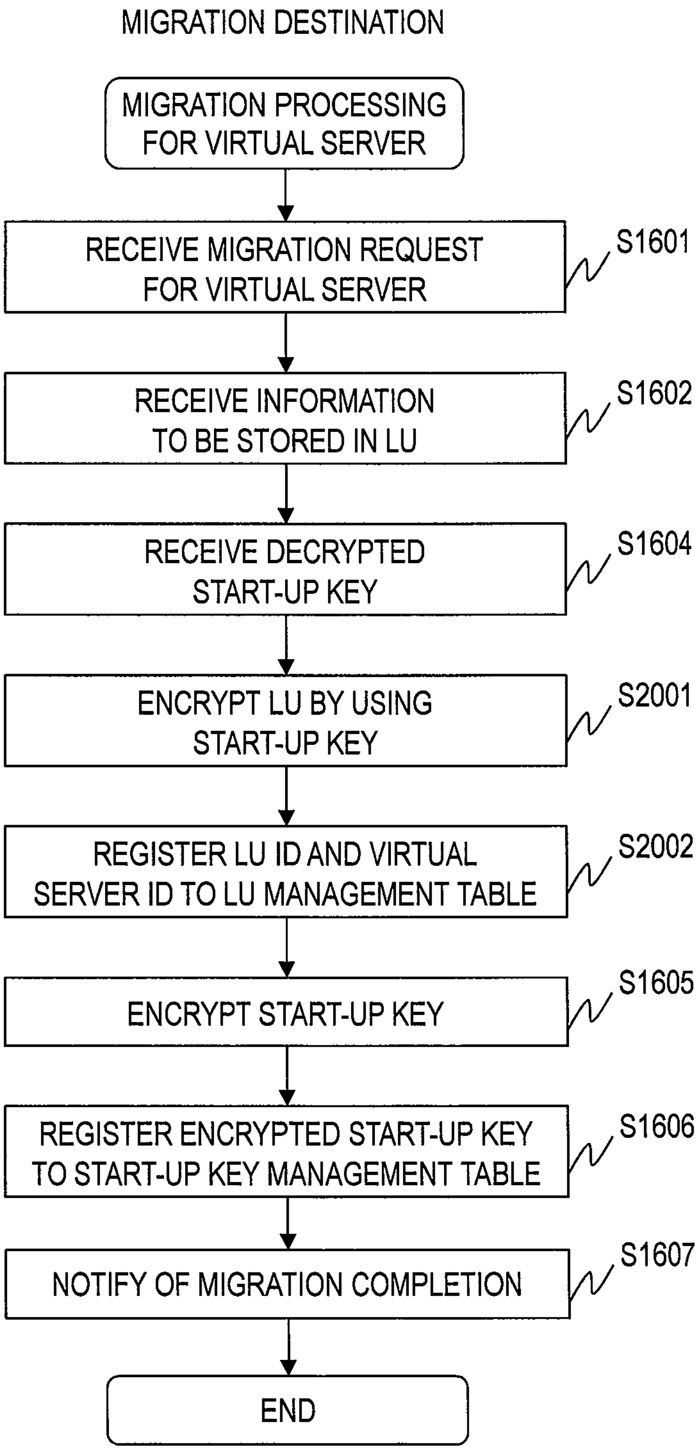

MIGRATION DESTINATION
MIGRATION PROCESSING FOR VIRTUAL SERVER
RECEIVE MIGRATION REQUEST FOR VIRTUAL SERVER
S1601
RECEIVE INFORMATION TO BE STORED IN LU
S1602
RECEIVE DECRYPTED START-UP KEY
S1604
ENCRYPT LU BY USING START-UP KEY
S2001
REGISTER LU ID AND VIRTUAL SERVER ID TO LU MANAGEMENT TABLE
S2002
ENCRYPT START-UP KEY
S1605
REGISTER ENCRYPTED START-UP KEY TO START-UP KEY MANAGEMENT TABLE
S1606
NOTIFY OF MIGRATION COMPLETION
S1607
END

Fig. 20

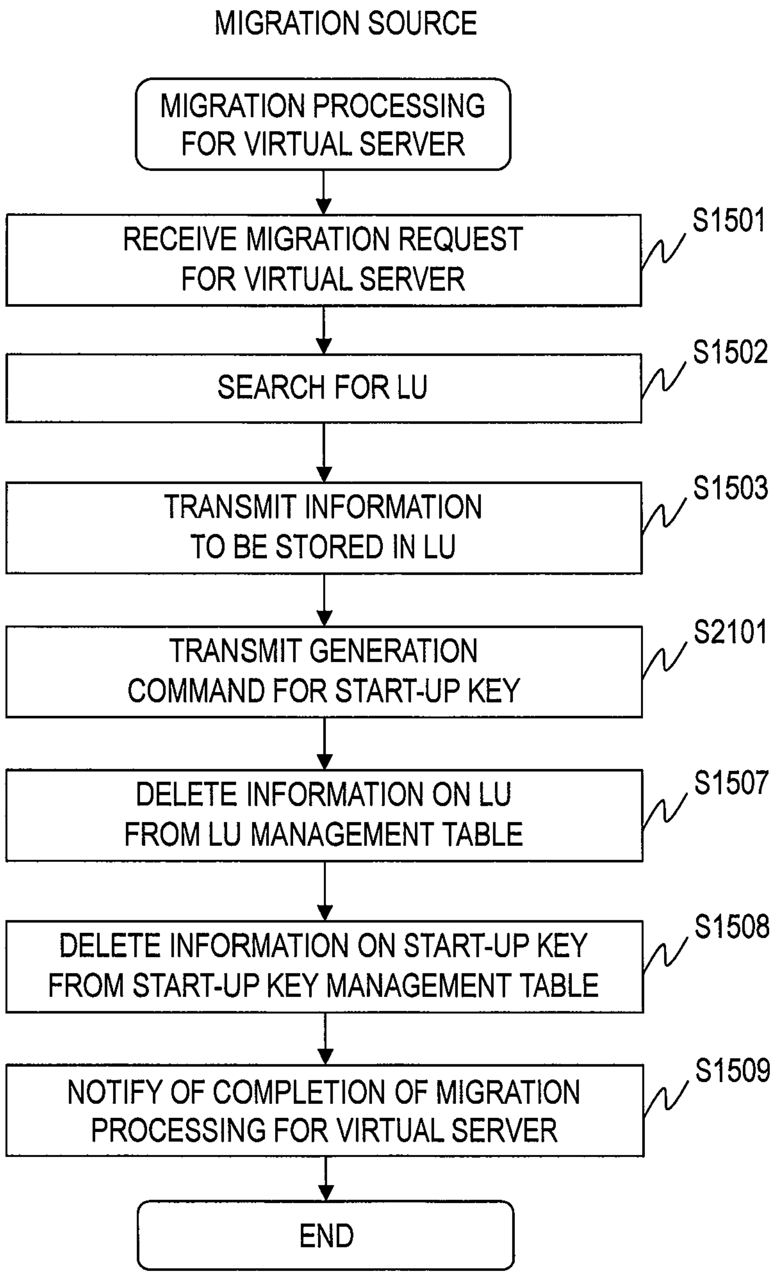

MIGRATION SOURCE
MIGRATION PROCESSING FOR VIRTUAL SERVER
RECEIVE MIGRATION REQUEST FOR VIRTUAL SERVER
S1501
SEARCH FOR LU
S1502
TRANSMIT INFORMATION TO BE STORED IN LU
S1503
TRANSMIT GENERATION COMMAND FOR START-UP KEY
S2101
DELETE INFORMATION ON LU FROM LU MANAGEMENT TABLE
S1507
DELETE INFORMATION ON START-UP KEY FROM START-UP KEY MANAGEMENT TABLE
S1508
NOTIFY OF COMPLETION OF MIGRATION PROCESSING FOR VIRTUAL SERVER
S1509
END

Fig. 21

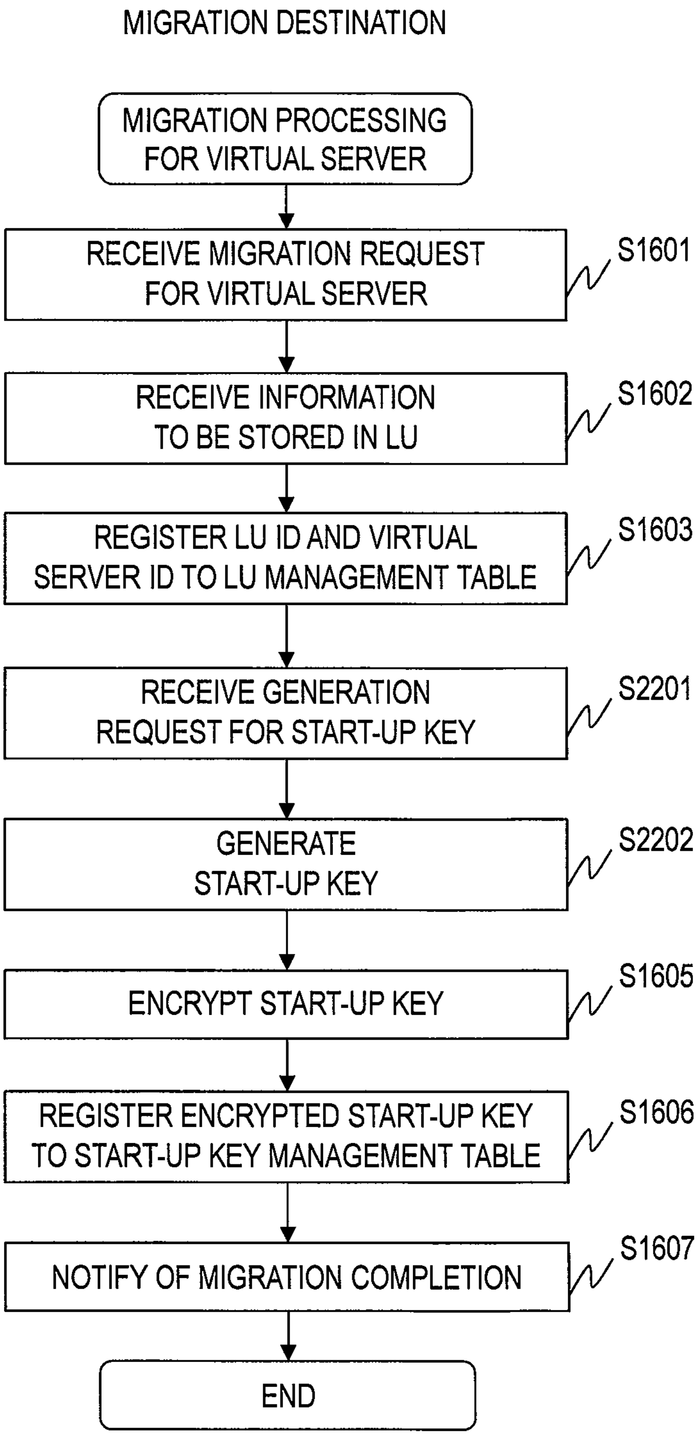

MIGRATION DESTINATION
MIGRATION PROCESSING FOR VIRTUAL SERVER
RECEIVE MIGRATION REQUEST FOR VIRTUAL SERVER
S1601
RECEIVE INFORMATION TO BE STORED IN LU
S1602
REGISTER LU ID AND VIRTUAL SERVER ID TO LU MANAGEMENT TABLE
S1603
RECEIVE GENERATION REQUEST FOR START-UP KEY
S2201
GENERATE START-UP KEY
S2202
ENCRYPT START-UP KEY
S1605
REGISTER ENCRYPTED START-UP KEY TO START-UP KEY MANAGEMENT TABLE
S1606
NOTIFY OF MIGRATION COMPLETION
S1607
END

Fig. 22

METHOD OF MANAGING VIRTUAL COMPUTER, COMPUTER SYSTEM AND COMPUTER

BACKGROUND OF THE INVENTION

This invention relates to a method of managing a virtual computer operating on a physical computer. This invention particularly relates to start-up processing for a virtual computer.

As the cloud computing becomes widespread, a user can carry out a service by using a plurality of physical computers (resources) installed in a datacenter providing a cloud service. In the datacenter, a plurality of virtual computers can be constituted by using a single physical computer (resource).

On the virtual computer, an OS for executing the service of the user and the like runs. The virtual computer is stored as an image file in a storage medium such as an HDD of the physical computer, and the virtual server can be moved to another physical computer by replacing of the HDD or migration of the image file to another physical computer.

Thus, an administrator or the like of the datacenter can migrate the virtual computer to another physical computer, and can start the virtual computer.

In the conventional management method, a malicious administrator or the like can acquire the image file of the virtual computer, and can start the virtual computer on another physical computer. In other words, there is such a problem that the obtaining of data and the hacking of the virtual server can be easily carried out.

As a method for restraining the virtual computer from being started at a timing not intended by a user, there is known a method involving restraining the start-up of the virtual computer in a case where a WWN corresponding to a virtual HBA assigned to the virtual computer has a value meaning start-up restraining (for example, refer to Japanese Patent Application Laid-open No. 2010-033403).

SUMMARY OF THE INVENTION

However, the invention described in Japanese Patent Application Laid-open No. 2010-033403 restrains the start-up of the virtual computer in the same physical computer, and does not restrain the start-up of the virtual computer that has migrated to another physical computer. In other words, the above-mentioned invention does not limit execution of the executable image of the virtual computer only to a specific physical computer.

Moreover, authentication processing between a management computer managing the datacenter and the physical computer cannot restrain the start-up of the virtual computer by a malicious administrator or the like.

This invention has been made in view of the above-mentioned problem, and therefore has an object to enable the start-up of a virtual computer only on a specific physical computer, and to restrain the start-up of the virtual computer on another physical computer.

The present invention can be appreciated by the description which follows in conjunction with the following figures, wherein: a method of managing a virtual computer in a computer system including a plurality of computers, the plurality of computers including a first computer. The first computer has a first processor, a first memory coupled to the first processor, a first network interface coupled to the first processor, and a first storage medium coupled to the first processor. The first memory stores a program for realizing a first virtualization management module for generating at least one virtual

computer by dividing a computer resource included in the computer and managing the at least one virtual computer. The first memory includes a first management storage area that is accessible only by the first virtualization management module. The first storage medium includes a logical storage area generated by logically dividing a storage area of the first storage medium. The logical storage area stores a service program for executing a service on the at least one virtual computer. The first management storage area stores first start-up management information representing a correspondence among identification information on the at least one virtual computer, identification information on the logical storage area of the first storage medium storing the service program, and start-up authentication information for starting the at least one virtual computer. The first computer has a first virtual computer for executing a first service program generated thereon. The method including: a first step of generating, by the first virtualization management module, first start-up authentication information, in a case of receiving a generation command for the start-up authentication information for starting the first virtual computer; a second step of storing, by the first virtualization management module, a correspondence among the identification information on the first virtual computer, the identification information on the logical storage area of the first storage medium storing the first service program, and the generated first start-up authentication information in the first start-up management information; a third step of referring, by the first virtualization management module, to the first start-up management information based on the identification information on the first virtual computer to determine whether the first start-up authentication information corresponding to the first virtual computer exists, in a case of receiving a start-up request for the first virtual computer including the identification information on the first virtual computer, a fourth step of reading, by the first virtualization management module, the first service program from the logical storage area of the first storage medium, in a case where the first virtualization management module determines that the first start-up authentication information corresponding to the first virtual computer exists in the first start-up management information; and a fifth step of starting, by the first virtualization management module, the first virtual computer by executing the read first service program.

According to this invention, the virtual computer is not started in a case where the start-up authentication information corresponding to the virtual computer does not exist in the start-up management information. Thus, even when a malicious administrator obtains the service program including the executable image of the virtual computer and the like, the virtual computer is not started on another computer, resulting in an increase in security.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention can be appreciated by the description which follows in conjunction with the following figures, wherein:

FIG. **1** is a block diagram illustrating an example of a computer system according to a first embodiment of this invention;

FIG. **2** is a block diagram illustrating details of a virtualization management module according to the first embodiment of this invention;

FIG. **3** is a block diagram illustrating a logical configuration of the computer system according to the first embodiment of this invention;

FIG. **4** is an explanatory diagram illustrating details of a start-up key management table according to the first embodiment of this invention;

FIG. **5** is an explanatory diagram illustrating details of a LU management table according to the first embodiment of this invention;

FIG. **6** is a flowchart illustrating an overview of processing to be executed in a case where the virtualization management module according to the first embodiment of this invention receives a user request;

FIG. **7** is a sequence diagram illustrating a flow of generation processing for a start-up key according to the first embodiment of this invention;

FIG. **8** is a flowchart illustrating details of the generation processing for a start-up key according to the first embodiment of this invention;

FIG. **9** is a sequence diagram illustrating a flow of deletion processing for a start-up key according to the first embodiment of this invention;

FIG. **10** is a flowchart illustrating details of the deletion processing for a start-up key according to the first embodiment of this invention;

FIG. **11**A is a sequence diagram illustrating a flow of start-up processing for a virtual server according to the first embodiment of this invention;

FIG. **11**B is a sequence diagram illustrating a flow of the start-up processing in a case where a start-up key for a virtual server is not used according to the first embodiment of this invention;

FIG. **12** is a flowchart illustrating details of authentication processing for a start-up key according to the first embodiment of this invention;

FIG. **13** is a flowchart illustrating details of authentication processing for an LU according to the first embodiment of this invention;

FIG. **14** is a sequence diagram illustrating a flow of migration processing for a virtual server according to the first embodiment of this invention;

FIG. **15** is a flowchart illustrating details of processing executed by the virtualization management module of a migration source according to the first embodiment of this invention;

FIG. **16** is a flowchart illustrating details of processing executed by the virtualization management module of a migration destination according to the first embodiment of this invention;

FIG. **17** is a flowchart illustrating details of the generation processing for a start-up key according to the second embodiment of this invention;

FIG. **18** is a flowchart illustrating details of the authentication processing for an LU according to the second embodiment of this invention;

FIG. **19** is a flowchart illustrating details of processing executed by the virtualization management module of the migration source according to the second embodiment of this invention;

FIG. **20** is a flowchart illustrating details of processing executed by the virtualization management module of the migration destination according to the second embodiment of this invention;

FIG. **21** is a flowchart illustrating details of processing executed by the virtualization management module of the migration source according to the third embodiment of this invention; and

FIG. **22** is a flowchart illustrating details of processing executed by the virtualization management module of the migration destination according to the third embodiment of this invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to the accompanying drawings, embodiments of this invention are described below. It should be noted that components assigned with the same reference numerals have the same configuration or function.

First Embodiment

FIG. **1** is a block diagram illustrating an example of a computer system according to a first embodiment of this invention.

The computer system according to this embodiment includes a plurality of physical servers **100**, a management server **120**, and a storage device **130**.

Each of the physical servers **100** is coupled to the management server **120** via a network **140**. The network **140** may be a network of any coupling type, and, for example, an IP network, a WAN, a LAN, and the like can be conceived. It should be noted that the physical server **100** and the management server **120** may be directly coupled to each other.

Moreover, the physical server **100** is coupled via a SAN or the like or directly to the storage device **130**. It should be noted that one of the physical servers **100** may be coupled to one storage device **130**, or the plurality of physical servers **100** may be coupled to one or a plurality of storage devices **130**.

The management server **120** manages the physical servers **100** in the computer system. The management server **120** includes at least a processor (not shown), a memory (not shown), a storage medium (not shown), and a network interface (not shown).

A program for realizing a virtual server start-up management module **121** and a virtual server migration management module **122** is read onto the memory (not shown), and is executed by the processor (not shown).

The virtual server start-up management module **121** provides an interface for inputting information required to start a virtual server **117**, and transmits information input to the interface to each of the physical servers **100**.

The virtual server migration management module **122** provides an interface for inputting information required for the migration of a virtual server **117**, and transmits information input to the interface to each of the physical servers **100**.

The storage device **130** stores information on the physical servers **100**. The storage device **130** includes a plurality of storage media **131**. It should be noted that the storage device **130** may constitute a disk array based on the plurality of storage media **131**, and may provide the physical server **100** with a logical storage area constituted by the disk array.

The physical server **100** includes a processor **101**, a memory **102**, a network interface **103**, and a disk interface **104**.

The processor **101** executes programs stored on the memory **102**. As a result, functions included in the physical server **100** can be realized.

The memory **102** temporarily stores a program to be executed by the processor **101**, and information necessary to execute the program. Specifically, a program for realizing a virtualization management module **110** is stored on the memory **102**.

The virtualization management module **110** generates a virtual server **117**, and manages the generated virtual server **117**. On the virtual server **117**, a guest OS **301** (refer to FIG. **3**) is executed.

For example, the virtualization management module **110** generates the virtual server **117** by dividing computer resources (such as the processor **101** and the memory **102**) included in the physical server **100** and assigning the divided computer resources to the virtual server **117**. The guest OS **301** (refer to FIG. **3**) to be executed on the virtual server **117** and the like are stored as an executable image of the virtual server **117** in the storage device **130**.

The assignment of the computer resources is hereinafter referred to as "generation of a virtual server **117**".

The virtualization management module **110** includes a start-up key processing module **111**, a virtual server start-up module **112**, a virtual server migration module **113**, a start-up key management table **114**, an LU management table **115**, and a decoder **116**.

The start-up key processing module **111** executes processing relating to a start-up key. Specifically, the start-up key processing module **111** generates the start-up key, and deletes the start-up key. Herein, the start-up key is authentication information required for start-up processing for a virtual server **117**.

The virtual server start-up module **112** executes start-up processing for a virtual server **117**.

The virtual server migration module **113** executes migration processing of migrating a virtual server **117** between the physical servers **100**.

The start-up key management table **114** stores each of relationships between a start-up key and a virtual server **117**. Referring to FIG. **4**, a detailed description is given later of the start-up key management table **114**.

The LU management table **115** stores information on storage areas storing virtual servers **117** and executable images of the virtual servers **117**. Referring to FIG. **5**, a detailed description is given later of the LU management table **115**.

The decoder **116** decodes encrypted information. According to this embodiment, the decoder **116** decrypts an encrypted start-up key.

The network interface **103** is an interface for coupling to the management server **120** via the network **140**.

The disk interface **104** is an interface for coupling to the storage device **130**.

FIG. **2** is a block diagram illustrating details of the virtualization management module **110** according to the first embodiment of this invention.

The start-up key processing module **111** includes a start-up key generation module **201** and a start-up key deletion module **202**.

The start-up key generation module **201** executes generation processing of generating a start-up key. Referring to FIGS. **7** and **8**, a description is given later of the generation processing for a start-up key.

The start-up key deletion module **202** executes deletion processing of deleting a start-up key. Referring to FIGS. **9** and **10**, a description is given later of the deletion processing for a start-up key.

It should be noted that the start-up key processing module **111** may hold the start-up key generation module **201** and the start-up key deletion module **202** as a single configuration.

The virtual server start-up module **112** includes a start-up key authentication module **211**, an LU authentication module **212**, and a start-up processing module **213**.

The start-up key authentication module **211** carries out authentication processing for a virtual server **117** based on a start-up key during the start-up processing. Referring to FIGS. **11**A, **11**B and **12**, a description is given later of the authentication processing for a start-up key.

The LU authentication module **212** executes the authentication processing for a storage area storing an executable image of a subject virtual server **117**. Referring to FIGS. **11**A, **11**B, and **13**, a description is given later of the authentication processing for a storage area.

The start-up processing module **213** executes start-up processing for a virtual server **117**.

It should be noted that the virtual server start-up module **112** may hold the start-up key authentication module **211**, the LU authentication module **212**, and the start-up processing module **213** as a single configuration.

The virtual server migration module **113** includes a start-up key transmission module **221**, a start-up key reception module **222**, and a migration processing module **223**.

The start-up key transmission module **221** transmits a start-up key to a physical server **100** of a migration destination during the migration processing.

The start-up key reception module **222** receives a start-up key transmitted from a physical server **100** of a migration source.

The migration processing module **223** migrates a virtual server **117** operating on a physical server **100** of a migration source to a physical server **100** of a migration destination.

The start-up key management table **114**, the LU management table **115**, and the decoder **116** have the same configurations as those of FIG. **1**, and a description thereof is therefore omitted.

FIG. **3** is a block diagram illustrating a logical configuration of the computer system according to the first embodiment of this invention.

On the memory **102** of the physical server **100**, the virtualization management module **110** is executed. On the virtualization management module **110**, a plurality of virtual servers **117** operate. Further, on each of the virtual servers **117**, the guest OS **301** is executed. As a result, a user can carry out his/her service.

The storage device **130** logically divides a storage area **310** of a disk array including a plurality of storage media **131** to generate a plurality of LUs **311**. Moreover, the storage device **130** provides the virtual server **117** with an LU **311**. To each of the LUs **311**, an LU ID **312** for uniquely identifying the LU **311** is assigned.

According to this embodiment, one LU **311** is assigned to one virtual server **117**. In other words, an executable image of the virtual server **117** including the guest OS **301** is stored in one LU **311**.

The virtualization management module **110** starts the virtual server **117** by reading the executable image of the virtual server **117** from the LU **311** and executing the read executable image during the start-up processing.

FIG. **4** is an explanatory diagram illustrating details of the start-up key management table **114** according to the first embodiment of this invention.

The start-up key management table **114** includes virtual server IDs **401** and start-up keys **402**.

The virtual server ID **401** is an identifier for uniquely identifying a virtual server **117** to be executed on a physical server **100**.

The start-up key **402** stores a start-up key for the virtual server **117** corresponding to the virtual server ID **401**.

The start-up key according to this embodiment is generated by using information specific to the virtualization management module **110**. For example, the start-up key is generated based on hardware information on a physical server **100** on which the virtualization management module **110** is operating. As a result, the virtual server **117** can be prevented from being started on another virtualization management module **110**.

According to this embodiment, the start-up key management table **114** is stored in a storage area which can be accessed only by the virtualization management module **110**. In other words, the management server **120**, other physical servers **100**, and the guest OSs **301** cannot access the start-up key management table **114**.

FIG. **5** is an explanatory diagram illustrating details of the LU management table **115** according to the first embodiment of this invention.

The LU management table **115** includes virtual server IDs **501** and LU IDs **502**.

The virtual server ID **501** is an identifier for uniquely identifying a virtual server **117** operating on the physical server **100**, and is the same information as the virtual server ID **401**.

The LU ID **502** is an identifier for uniquely identifying an LU **311**.

It should be noted that the virtualization management module **110** may combine the start-up key management table **114** and the LU management table **115** to hold the information as one table.

FIG. **6** is a flowchart illustrating an overview of processing to be executed in a case where the virtualization management module **110** according to the first embodiment of this invention receives a user request.

The virtualization management module **110** receives a user request transmitted from the management server **120** (Step **601**).

The virtualization management module **110** determines whether or not the received user request is a generation request for a start-up key (Step **602**).

In a case where the virtualization management module **110** determines that the received user request is the generation request for a start-up key, the virtualization management module **110** executes the generation processing for a start-up key (Step **606**). It should be noted that, referring to FIGS. **7** and **8**, a detailed description is given later of the generation processing for a start-up key.

In a case where the virtualization management module **110** determines that the received user request is not the generation request for an start-up key, the virtualization management module **110** determines whether or not the received user request is a deletion request for an start-up key (Step **603**).

In a case where the virtualization management module **110** determines that the received user request is the deletion request for a start-up key, the virtualization management module **110** executes the deletion processing for a start-up key (Step **607**). It should be noted that, referring to FIGS. **9** and **10**, a detailed description is given later of the deletion processing for a start-up key.

In a case where the virtualization management module **110** determines that the received user request is not the deletion request for an start-up key, the virtualization management module **110** determines whether or not the received user request is an start-up request for the virtual server **117** (Step **604**).

In a case where the virtualization management module **110** determines that the received user request is the start-up request for the virtual server **117**, the virtualization management module **110** executes the start-up processing for the virtual server **117** (Step **608**). It should be noted that, referring to FIGS. **11**A, **11**B, **12**, and **13**, a detailed description is given later of the start-up processing for the virtual server **117**.

In a case where the virtualization management module **110** determines that the received user request is not the start-up request for the virtual server **117**, the virtualization management module **110** determines whether or not the received user request is a migration request for the virtual server **117** (Step **605**).

In a case where the virtualization management module **110** determines that the received user request is the migration request for the virtual server **117**, the virtualization management module **110** executes the migration processing for the virtual server **117** (Step **609**). It should be noted that, referring to FIGS. **14**, **15** and **16**, a detailed description is given later of the migration processing for the virtual server **117**.

In a case where the virtualization management module **110** determines that the received user request is not the migration request for the virtual server **117**, the virtualization management module **110** finishes the processing. It should be noted that the virtualization management module **110** may execute other processing corresponding to the received user request.

A detailed description is now given of processing corresponding to the user request. First, a description is given of the generation processing for a start-up key.

FIG. **7** is a sequence diagram illustrating a flow of the generation processing for a start-up key according to the first embodiment of this invention.

An administrator or a user inputs the generation request for a start-up key into the management server **120** (Step **701**). It should be noted that the generation request includes a virtual server ID.

Timings when the generation request for a start-up key is input may include a case where a new virtual server **117** is assigned to the user, and a case where a start-up key is newly generated for a virtual server **117** which has already been assigned to the user.

The management server **120** transmits the generation request for a start-up key including the virtual server ID to the virtualization management module **110**. It should be noted that the management server **120** holds a table (not shown) for storing information on virtual servers **117** which operate on each physical server **100**, and can identify a physical server **100** to which the generation request for a start-up key is to be transmitted by referring to the table.

In a case where the virtualization management module **110** receives the generation request for a start-up key from the management server **120** (Step **702**), the virtualization management module **110** generates a start-up key (Step **703**).

The virtualization management module **110** updates the start-up key management table **114** based on the generated start-up key (Step **704**).

The virtualization management module **110** transmits a completion notification representing completion of the generation processing for the start-up key to the management server **120** (Step **705**).

The management server **120** notifies the administrator or the user of the completion notification.

FIG. **8** is a flowchart illustrating details of the generation processing for a start-up key according to the first embodiment of this invention.

In a case where the virtualization management module **110** receives the generation request for a start-up key from the management server **120** (Step **801**), the virtualization management module **110** invokes the start-up key processing module **111**. The invoked start-up key processing module **111** executes the start-up key generation module **201**. The following processing is executed by the start-up key generation module **201**.

First, the start-up key generation module **201** generates a start-up key (Step **802**).

As the generation method for a start-up key, for example, a method of obtaining a hash value from information specific to the virtualization management module **110** and generating a start-up key based on the hash value is conceivable. It should be noted that this invention is not limited by the generation method for a start-up key, and any method may be used.

Then, the start-up key generation module **201** encrypts the generated start-up key (Step **803**). According to this embodiment, the start-up key is encrypted by using information specific to the virtualization management module **110**.

As the encryption method, a method using the public-key cryptography such as the RSA cryptography is conceivable. It should be noted that this invention is not limited by the encryption method.

The start-up key generation module **201** updates the start-up key management table **114** based on the encrypted start-up key (Step **804**).

Specifically, when an entry corresponding to the virtual server ID contained in the generation request for the start-up key exists in the start-up key management table **114**, the start-up key generation module **201** updates a column for the start-up key **402** of the entry. Moreover, when an entry corresponding to the virtual server ID contained in the generation request for the start-up key does not exist in the start-up key management table **114**, the start-up key generation module **201** newly adds an entry.

The start-up key generation module **201** transmits a completion notification for the generation processing for the start-up key to the management server **120** (Step **805**), and finishes the processing.

According to this invention, the start-up key is generated by using the information specific to the virtualization management module **110**, and further, the start-up key is encrypted by using the information specific to the virtualization management module **110**. As a result, even when the executable image of the virtual server **117** is illegally obtained, other virtualization management modules **110** cannot decrypt the start-up key, and further, the virtual server **117** cannot be started due to a difference in start-up key. Therefore, the security can be enhanced.

Now, a description is given of the deletion processing for a start-up key.

FIG. **9** is a sequence diagram illustrating a flow of the deletion processing for a start-up key according to the first embodiment of this invention.

The administrator or the user inputs a deletion request for a start-up key into the management server **120** (Step **901**). It should be noted that the deletion request includes a virtual server ID.

Timings when the deletion request for the start-up key is input may include a case where a virtual server **117** assigned to a user is to be deleted.

The management server **120** transmits the deletion request for a start-up key including the virtual server ID to the virtualization management module **110**. It should be noted that the management server **120** holds the table (not shown) for storing the information on the virtual servers **117** which operate on each physical server **100**, and can identify a physical server **100** to which the deletion request for an start-up key is to be transmitted by referring to the table.

In a case where the virtualization management module **110** receives the deletion request for the start-up key from the management server **120** (Step **902**), the virtualization management module **110** searches for the start-up key (Step **903**).

The virtualization management module **110** deletes information corresponding to the retrieved start-up key from the start-up key management table **114** (Step **904**).

The virtualization management module **110** transmits a completion notification representing completion of the deletion of the start-up key to the management server **120** (Step **905**).

The management server **120** notifies the administrator or the user of the completion notification.

FIG. **10** is a flowchart illustrating details of the deletion processing for a start-up key according to the first embodiment of this invention.

In a case where the virtualization management module **110** receives the deletion request for a start-up key from the management server **120** (Step **1001**), the virtualization management module **110** invokes the start-up key processing module **111**. The invoked start-up key processing module **111** executes the start-up key deletion module **202**. The following processing is executed by the start-up key deletion module **202**.

First, the start-up key deletion module **202** searches for the start-up key from the start-up key management table **114**, based on the virtual server ID included in the received deletion request for the start-up key (Step **1002**). Specifically, the start-up key deletion module **202** searches for an entry, matching the virtual server ID included in the deletion request for the start-up key, from the start-up key management table **114**.

The start-up key deletion module **202** deletes the retrieved start-up key from the start-up key management table **114** (Step **1003**). Specifically, the start-up key deletion module **202** deletes the entry matching the virtual server ID included in the deletion request for the start-up key from the start-up key management table **114**.

The start-up key deletion module **202** transmits a completion notification for the deletion processing for the start-up key to the management server **120** (Step **1004**), and finishes the processing.

Now, a description is given of the start-up processing for a virtual server.

FIG. **11**A is a sequence diagram illustrating a flow of the start-up processing for a virtual server according to the first embodiment of this invention.

The administrator or the user inputs a start-up request for a virtual server **117** into the management server **120** (Step **1101**). It should be noted that the start-up request includes a virtual server ID.

The virtual server **117** to be started is hereinafter also referred to as subject virtual server **117**.

The management server **120** transmits the start-up request for a virtual server including the virtual server ID to the virtualization management module **110**. It should be noted that the management server **120** holds the table (not shown) for storing the information on the virtual servers **117** which operate on each physical server **100**, and can identify a physical server **100** to which the start-up request for a virtual server is to be transmitted by referring to the table.

In a case where the virtualization management module **110** receives the start-up request for a virtual server **117** from the management server **120** (Step **1102**), the virtualization management module **110** determines, by search, whether or not a corresponding start-up key exists (Step **1103**). In other words, the authentication processing for the start-up key is executed.

Then, the virtualization management module **110** determines, by search, whether or not a corresponding LU exists (Step **1104**). In other words, the authentication processing for the LU is executed.

The virtualization management module **110** starts up the subject virtual server **117** corresponding to the virtual server ID included in the start-up request for the virtual server **117** (Step **1105**).

Specifically, after the authentication processing for the LU has been completed, the virtualization management module **110** reads an executable image of the virtual server **117** from the LU **311**, and executes the read executable image of the virtual server **117**.

The virtualization management module **110** transmits a completion notification representing completion of the start-up processing for the virtual server to the management server **120** (Step **1106**).

The management server **120** notifies the administrator or the user of the completion notification.

FIG. **11**B is a sequence diagram illustrating a flow of the start-up processing in a case where a start-up key for a virtual server **117** is not used according to the first embodiment of this invention.

As illustrated in FIG. **11**B, in a case where a start-up key is not used, the authentication processing for a start-up key in Step **1103** is not executed.

The other processing is the same, and a description thereof is therefore omitted.

FIG. **12** is a flowchart illustrating details of the authentication processing for a start-up key according to the first embodiment of this invention.

In a case where the virtualization management module **110** receives the start-up request for a start-up key from the management server **120**, the virtualization management module **110** invokes the server start-up module **112**. The invoked virtual server start-up module **112** executes the start-up key authentication module **211**. The following processing is executed by the start-up key authentication module **211**.

The start-up key authentication module **211** extracts a virtual server ID from the received start-up request for a virtual server (Step **1201**).

The start-up key authentication module **211** refers to the start-up key management table **114** based on the extracted virtual server ID to search for a start-up key (Step **1202**). Specifically, the start-up key authentication module **211** searches for an entry, matching the extracted virtual server ID, from the start-up key management table **114**.

The start-up key authentication module **211** determines whether or not a start-up key corresponding to the extracted virtual server ID exists as a result of the search (Step **1203**). In other words, it is determined whether or not an entry matching the extracted virtual server ID exists in the start-up key management table **114**.

In a case where the start-up key authentication module **211** determines that a start-up key corresponding to the extracted virtual server ID does not exist, the start-up key authentication module **211** notifies the virtual server start-up module **112** of the failure in the authentication (Step **1206**), and finishes the processing. In other words, the virtual server **117** is not started.

In a case where the start-up key authentication module **211** determines that a start-up key corresponding to the extracted virtual server ID exists, the start-up key authentication module **211** reads the start-up key from the start-up key management table **114**, and determines whether or not the read start-up key can be decrypted (Step **1207**).

Specifically, the decoder **116** is executed to determine whether or not the read start-up key can be decrypted.

On this occasion, the start-up key is encrypted based on the information specific to the virtualization management module **110**, and hence a different virtualization management module **110** cannot decrypt the start-up key. In other words, even if the start-up key is illegally obtained, in a case where the obtained start-up key cannot be decrypted, the virtual server **117** is restrained from being started.

In a case where the start-up key authentication module **211** determines that the read start-up key cannot be decrypted, the start-up key authentication module **211** notifies the virtual server start-up module **112** of the failure in the authentication (Step **1206**), and finishes the processing. In other words, the virtual server **117** is not started.

In a case where the start-up key authentication module **211** determines that the read start-up key can be decrypted, the start-up key authentication module **211** notifies the virtual server start-up module **112** of the completion of the authentication processing for the start-up key (Step **1205**), and finishes the processing.

As described above, according to this embodiment, in a case where a start-up key corresponding to a virtual server **117** does not exist, the virtual server **117** is not started.

FIG. **13** is a flowchart illustrating details of the authentication processing for an LU according to the first embodiment of this invention.

In a case where the virtual server start-up module **112** receives the notification of the completion of the authentication processing for a start-up key, the virtual server start-up module **112** executes the LU authentication module **212**. The following processing is executed by the LU authentication module **212**.

The LU authentication module **212** extracts a virtual server ID from the received start-up request for a virtual server (Step **1301**).

The LU authentication module **212** refers to the LU management table **115** based on the extracted virtual server ID, and searches for an LU **311** corresponding to the extracted virtual server ID (Step **1302**). Specifically, the LU authentication module **212** searches for an entry, matching the extracted virtual server ID, from the LU management table **115**.

The LU authentication module **212** determines whether or not, as a result of the search, an LU **311** corresponding to the extracted virtual server ID exists (Step **1303**). In other words, it is determined whether or not an entry matching the extracted virtual server ID exists in the LU management table **115**.

In a case where the LU authentication module **212** determines that an LU **311** corresponding to the extracted virtual server ID does not exist, the LU authentication module **212** notifies the virtual server start-up module **112** of the failure in the authentication (Step **1306**), and finishes the processing. In other words, the virtual server **117** is not started.

When the LU authentication module **212** determines that an LU **311** corresponding to the extracted virtual server ID exists, the LU authentication module **212** notifies the virtual server start-up module **112** of completion of the authentication processing for the LU (Step **1305**), and finishes the processing.

Now, a description is given of the migration processing for a virtual server.

FIG. **14** is a sequence diagram illustrating a flow of the migration processing for a virtual server **117** according to the first embodiment of this invention.

In the migration processing for a virtual server, the virtualization management module **110** of the physical server **100** of a migration source and the virtualization management module **110** of the physical server **100** of a migration destination cooperate to execute the processing.

The virtualization management module **110** of the physical server **100** of the migration source is hereinafter referred to as virtualization management module **110-1**, and the virtualization management module **110** of the physical server **100** of the migration destination is hereinafter referred to as virtualization management module **110-2**.

The administrator or the user inputs the virtual server ID and identification information on the physical server **100** of the migration destination into the management server **120**, and transmits a migration request for the virtual server **117** (Step **1401**).

It should be noted that timings when the migration request for the virtual server **117** is input can include a planned migration and a failure occurrence.

The management server **120** transmits the migration request for the virtual server **117** to the virtualization management modules **110-1** and **110-2**.

It should be noted that the management server **120** holds the table (not shown) for storing the information on the virtual servers **117** operating on the respective physical servers **100**, and can identify the physical server **100** to which the migration request for the virtual server **117** is to be transmitted by referring to the table. Moreover, the management server **120** holds a table (not shown) for managing identification information on the physical servers **100**, and can identify the physical server **100** to which the migration request for the virtual server **117** is to be transmitted by referring to the table.

As a communication method performed between the virtualization management modules **110-1** and **110-2**, the following methods are conceivable.

For example, a method of generating, by the management server **120**, a communication path coupling the virtualization management modules **110-1** and **110-2** to each other so that the virtualization management modules **110-1** and **110-2** use the communication path to transmit/receive information to/from each other is conceivable.

Moreover, the virtualization management modules **110-1** and **110-2** may transmit/receive information to/from each other via the management server **120**. In this case, the information transmitted/received between the virtualization management modules **110-1** and **110-2** is preferably encrypted.

Referring back to FIG. **14**, a description is given.

In a case where the virtualization management module **110-1** receives the migration request for the virtual server **117** from the management server **120** (Step **1402**), the virtualization management module **110-1** transmits information relating to the virtual server **117** to be migrated to the virtualization management module **110-2** of the migration destination (Step **1404**).

The information relating to the virtual server **117** to be migrated is hereinafter referred to as migration information. The migration information includes configuration information on the virtual server **117** to be migrated, and an executable image of the virtual server **117** to be migrated. It should be noted that the migration information may include other information.

The virtualization management module **110-2** receives the migration request for the virtual server **117** from the management server **120** (Step **1403**). Moreover, the virtualization management module **110-2** receives the migration information from the virtualization management module **110-1** (Step **1405**).

The virtualization management module **110-2** generates a virtual server **117** based on the received migration information. Moreover, the virtualization management module **110-2** stores the executable image of the virtual server **117** in an LU **311**.

It should be noted that a virtual server **117** may not be newly generated in a case where a virtual server **117** having the same configuration as the virtual server **117** of the migration source has been generated on the physical server **100** of the migration destination. In this case, the virtual server **117** generated on the physical server **100** of the migration destination and the virtual server ID only needs to be associated with each other.

Then, the virtualization management module **110-1** reads a start-up key corresponding to the virtual server **117** to be migrated from the start-up key management table **114**, and transmits the read start-up key to the virtualization management module **110-2** (Step **1406**).

After the virtualization management module **110-1** transmits the start-up key, the virtualization management module **110-1** updates the start-up key management table **114** and the LU management table **115** (Step **1408**). Specifically, the virtualization management module **110-1** deletes entries corresponding to the virtual server **117** that has been migrated from the start-up key management table **114** and the LU management table **115**.

In a case where the virtualization management module **110-2** receives the start-up key (Step **1407**), the virtualization management module **110-2** updates the start-up key management table **114** and the LU management table **115** (Step **1409**). Specifically, the virtualization management module **110-2** adds entries corresponding to the virtual server **117** that has been migrated to the start-up key management table **114** and the LU management table **115**.

The virtualization management module **110-1** transmits a completion notification representing completion of the migration processing for the virtual server **117** to the management server **120** (Step **1410**).

It should be noted that, as the timing when the completion notification is transmitted, the virtualization management module **110-1** transmits the completion notification after the notification that the setting of the virtual server **117** is completed is received from the virtualization management module **110-2**. Moreover, the virtualization management module **110-2** may transmit the completion notification to the management server **120**.

The management server **120** notifies the administrator or the user of the completion notification.

FIG. **15** is a flowchart illustrating details of processing executed by the virtualization management module **110-1** of the migration source according to the first embodiment of this invention.

In a case where the virtualization management module **110-1** receives from the management server **120** the migration request for the virtual server **117** including the virtual server ID (Step **1501**), the virtualization management module **110-1** starts the virtual server migration module **113**. The following processing is executed by the virtual server migration module **113**.

First, the virtual server migration module **113** executes the migration processing module **223**.

The migration processing module **223** searches for an LU **311** that stores the executable image of the virtual server **117** to be migrated (Step **1502**).

Specifically, the migration processing module **223** extracts a virtual server ID from the migration request for the virtual server **117**. The migration processing module **223** refers to the LU management table **115** based on the extracted virtual server ID, and searches for an entry matching the extracted virtual server ID.

Moreover, the migration processing module **223** obtains the configuration information on the virtual server **117** to be migrated.

Then, the migration processing module **223** reads the executable image of the virtual server **117** stored in the retrieved LU **311**, and transmits, to the virtualization management module **110-2** of the migration destination, the migration information including the read executable image of the virtual server **117** (Step **1503**).

When the above-mentioned processing is finished, the virtual server migration module **113** then executes the start-up key transmission module **221**.

First, the start-up key transmission module **221** searches for a start-up key corresponding to the virtual server **117** to be migrated (Step **1504**).

Specifically, the start-up key transmission module **221** extracts a virtual server ID from the migration request for the virtual server **117**. The start-up key transmission module **221** refers to the start-up key management table **114** based on the extracted virtual server ID, and searches for an entry matching the extracted virtual server ID.

The start-up key transmission module **221** reads the start-up key from the start-up key management table **114**, and decrypts the read start-up key (Step **1505**). It should be noted that the decoder **116** is used for the decryption.

The start-up key transmission module **221** transmits the decrypted start-up key to the virtualization management module **110-2** of the migration destination (Step **1506**).

In a case where the above-mentioned processing has been completed, the virtual server migration module **113** deletes an entry corresponding to the virtual server **117** that has been migrated from the LU management table **1507** (Step **1507**), and deletes an entry corresponding to the virtual server **117** that has been migrated from the start-up key management table **114** (Step **1508**).

The virtual server migration module **113** transmits a completion notification for the migration processing for the virtual server **117** to the management server **120** (Step **1509**), and finishes the processing.

FIG. **16** is a flowchart illustrating details of processing executed by the virtualization management module **110-2** of the migration destination according to the first embodiment of this invention.

In a case where the virtualization management module **110-2** of the migration destination receives from the management server **120** the migration request for the virtual server **117** including the virtual server ID (Step **1601**), the virtualization management module **110-2** executes the virtual server migration module **113**. The following processing is executed by the virtual server migration module **113**.

In a case where the virtual server migration module **113** receives the migration information including the executable image of the virtual server **117** from the virtualization management module **110-1** of the migration source (Step **1602**), the virtual server migration module **113** executes the migration processing module **223**. The migration processing module **223** stores the executable image of the virtual server **117** included in the received migration information in an LU **311**.

The migration processing module **223** associates the virtual server ID included in the migration request for the virtual server **117**, and the LU ID of the LU **311** storing the executable image of the virtual server **117** with each other, and registers the virtual server ID and the LU ID associated with each other to the LU management table **115** (Step **1603**).

Then, the virtual server migration module **113** receives the start-up key for the virtual server **117** to be migrated from the virtualization management module **110-1** by executing the start-up key reception module **222** (Step **1604**). It should be noted that the received start-up key is the decrypted start-up key.

The virtual server migration module **113** encrypts the start-up key (Step **1605**). As the method for encryption, the same method as in Step **803** is may be employed.

The virtual server migration module **113** registers the virtual server ID included in the migration request for the virtual server **117** and the encrypted start-up key that are associated with each other to the start-up key management table **114** (Step **1606**).

The virtual server migration module **113** notifies the virtualization management module **110-1** of the migration completion (Step **1607**), and finishes the processing.

As described above, the start-up key is encrypted also in the virtualization management module **110** of the migration destination. Thus, other virtualization management modules **110** cannot decrypt the start-up key, and hence cannot start the virtual server **117**.

According to the first embodiment of this invention, the virtualization management module **110** can start a virtual server **117** only when the virtualization management module **110** holds a start-up key required to start the virtual server **117**. As a result, a virtual server **117** is restrained from being started on a virtualization management module **110** that does not hold a corresponding start-up key. Thus, it is possible to restrain a malicious administrator or the like from starting an executable image of the virtual server **117** on other physical server **100**.

Moreover, the start-up key is stored in the storage area that can be accessed only by the virtualization management module **110**, and hence cannot be acquired from the outside such as the management server **120**.

Further, even if the virtualization management module **110** holds a start-up key, when the virtualization management module **110** cannot decrypt the start-up key, the virtual server **117** is restrained from being started. As a result, the security can be enhanced more.

Second Embodiment

A second embodiment is different in such a point that the executable image of the virtual server **117** stored in the LU is further encrypted by using the start-up key. In the following, a description is mainly given of the difference from the first embodiment.

Configurations of the computer system, the physical servers **100**, the management server **120**, and the storage device **130** of the second embodiment are the same as those of the first embodiment, and a description thereof is therefore omitted.

According to the second embodiment, the generation processing for a start-up key, the authentication processing for the start-up key, and the authentication processing for an LU are different.

FIG. **17** is a flowchart illustrating details of the generation processing for a start-up key according to the second embodiment of this invention.

Processing in Steps **801** to **805** is the same as that of the first embodiment, and a description thereof is therefore omitted. According to the second embodiment, new processing is executed after Step **802**.

After the start-up key generation module **201** generates the start-up key, the start-up key processing module **111** encrypts the LU **311** storing the executable image of the virtual server **117** by using the generated start-up key (Step **1701**). For example, a method of encrypting the LU **311** while the start-up key is used as an encryption key is conceivable.

Then, the start-up key generation module **201** continues the processing.

FIG. **18** is a flowchart illustrating details of the authentication processing for an LU according to the second embodiment of this invention.

Processing in Steps **1301** to **1305** is the same as that of the first embodiment, and a description thereof is therefore omitted. According to the second embodiment, new processing is executed after Step **1303**.

In Step **1303**, in a case where the LU authentication module **212** determines that an LU **311** corresponding to the extracted virtual server ID exists, the LU authentication module **212** reads the start-up key from the start-up key management table **114** to use the read start-up key to decrypt the corresponding LU **311** (Step **1801**).

FIG. **19** is a flowchart illustrating details of processing executed by the virtualization management module **110-1** of the migration source according to the second embodiment of this invention.

Processing in Steps **1501**, **1502**, and **1504** to **1509** is the same as that of the first embodiment, and hence a description thereof is omitted.

According to the second embodiment, the start-up key is searched for (Step **1504**) after the LU **311** is searched for (Step **1502**). This is executed to decrypt the encrypted LU **311**.

After Step **1505**, the migration processing module **223** decrypts the LU **311** storing the executable image of the virtual server **117** to be migrated by using the decrypted start-up key (Step **1901**).

Then, the migration processing module **223** reads the executable image of the virtual server **117** stored in the decrypted LU **311**, and transmits the migration information including the read executable image of the virtual server **117** to the virtualization management module **110-2** of the migration destination (Step **1902**).

It should be noted that the migration processing module **223** may transmit the encrypted executable image itself of the virtual server **117** to the virtualization management module **110-2** of the migration destination.

FIG. **20** is a flowchart illustrating details of processing executed by the virtualization management module **110-2** of the migration destination according to the second embodiment of this invention.

Processing in Steps **1601**, **1602**, **1604**, and **1605** to **1607** is the same as that of the first embodiment, and hence a description thereof is omitted.

After the migration processing module **223** receives the executable image of the virtual server **117** and the decrypted start-up key (Steps **1602** and **1604**), the migration processing module **223** encrypts the LU **311** storing the executable image of the virtual server **117** by using the received start-up key (Step **2001**).

The migration processing module **223** associates the virtual server ID included in the migration request for the virtual server **117** and the LU ID of the LU **311** storing the executable image of the virtual server **117** with each other, and registers the virtual server ID and the LU ID that are associated with each other to the LU management table **115** (Step **2002**).

According to the second embodiment, the security can further be enhanced by the virtualization management module **110** using the start-up key to encrypt the executable image itself of the virtualization server **117**.

Third Embodiment

A third embodiment is different in such a point that, in the migration processing, the virtualization management module **110** of the migration source transmits a generation command for a start-up key to the virtualization management module **110** of the migration destination. In other words, during the migration processing, the start-up key is not transmitted to the virtualization management module **110** of the migration destination, but the virtualization management module **110** of the migration destination newly generates the start-up key. In the following, a description is mainly given of the difference from the first embodiment.

Configurations of the computer system, the physical servers **100**, the management server **120**, and the storage device **130** of the third embodiment are the same as those of the first embodiment, and a description thereof is therefore omitted.

FIG. **21** is a flowchart illustrating details of processing executed by the virtualization management module **110-1** of the migration source according to the third embodiment of this invention.

Processing in Steps **1501** to **1503** and **1507** to **1509** is the same as that of the first embodiment, and hence a description thereof is omitted.

After the executable image of the virtual server **117** is transmitted (Step **1503**), the start-up key transmission module **221** transmits the generation command for the start-up key to the virtualization management module **110-2** (Step **2101**). It should be noted that the generation command may include information for generating the start-up key.

FIG. **22** is a flowchart illustrating details of processing executed by the virtualization management module **110-2** of the migration destination according to the third embodiment of this invention.

Processing in Steps **1601** to **1603** and **1605** to **1607** is the same as that of the first embodiment, and hence a description thereof is omitted.

In a case where the virtual server migration module **113** receives the generation request for the start-up key by executing the start-up key reception module **222** (Step **2201**), the virtual server migration module **113** invokes the start-up key processing module **111** to request the generation of the start-up key.

The invoked start-up key processing module **111** generates the start-up key by executing the start-up key generation module **201** (Step **2202**). It should be noted that, as a generation method for the start-up key, the same method as in Step **802** is used.

The start-up key processing module **111** notifies the virtual server migration module **113** of, along with the generated start-up key, the completion of the generation of the start-up key. The virtual server migration module **113** that has received the notification resumes the processing.

According to the third embodiment of this invention, the start-up key is not transmitted during the migration processing, and hence a risk of obtaining of the start-up key by means of communication interception or other such method is eliminated. The security can thus further be enhanced.

It should be noted that, according to this invention, the first, second and third embodiments may be combined.

Though the detailed description has been given of this invention referring to the attached drawings, this invention is not limited to this specific configuration, and includes various variations and equivalent configurations within the scope of the accompanying claims.

What is claimed is:

1. A method of managing a virtual computer in a computer system including a plurality of computers,

the plurality of computers including a first computer,

the first computer having a first processor, a first memory coupled to the first processor, a first network interface coupled to the first processor, and a first storage medium coupled to the first processor,

the first memory storing a program for realizing a first virtualization management module for generating at least one virtual computer by dividing a computer resource included in the computer and managing the at least one virtual computer,

the first memory including a first management storage area that is accessible only by the first virtualization management module,

the first storage medium including a logical storage area generated by logically dividing a storage area of the first storage medium,

the logical storage area storing a service program for executing a service on the at least one virtual computer,

the first management storage area storing first start-up management information representing a correspondence among identification information on the at least one virtual computer, identification information on the logical storage area of the first storage medium storing the service program, and start-up authentication information for starting the at least one virtual computer,

the first computer having a first virtual computer for executing a first service program generated thereon,

the method comprising:

a first step of generating, by the first virtualization management module, first start-up authentication information, in a case of receiving a generation command for the start-up authentication information for starting the first virtual computer;

a second step of storing, by the first virtualization management module, a correspondence among the identification information on the first virtual computer, the identification information on the logical storage area of the first storage medium storing the first service program, and the generated first start-up authentication information in the first start-up management information;

a third step of referring, by the first virtualization management module, to the first start-up management information based on the identification information on the first virtual computer to determine whether the first start-up authentication information corresponding to the first virtual computer exists, in a case of receiving a start-up request for the first virtual computer including the identification information on the first virtual computer;

a fourth step of reading, by the first virtualization management module, the first service program from the logical storage area of the first storage medium, in a case where the first virtualization management module determines that the first start-up authentication information corresponding to the first virtual computer exists in the first start-up management information; and

a fifth step of starting, by the first virtualization management module, the first virtual computer by executing the read first service program.

2. The method of managing a virtual computer according to claim **1**, wherein:

the first step further includes encrypting the generated first start-up authentication information; and

the second step includes storing a correspondence among the identification information on the first virtual computer, the identification information on the logical storage area storing the first service program, and the encrypted first start-up authentication information in the first start-up management information.

3. The method of managing a virtual computer according to claim **2**, wherein:

the third step includes determining whether the encrypted first start-up authentication information corresponding to the first virtual computer exists; and

the fourth step includes:

determining whether the encrypted first start-up authentication information is decryptable, in a case where it is determined that the encrypted first start-up authentication information corresponding to the first virtual computer exists; and

reading, the first service program from the logical storage area of the first storage medium, in a case where it is determined that the encrypted first start-up authentication information is decryptable.

4. The method of managing a virtual computer according to claim **2**, wherein:

the plurality of computers include a second computer;

the second computer has a second processor, a second memory coupled to the second processor, a second network interface coupled to the second processor, and a second storage medium coupled to the second processor;

the second memory stores a program for realizing a second virtualization management module for generating the at least one virtual computer and managing the generated at least one virtual computer;

the second memory includes a second management storage area that is accessible only by the second virtual management module and that stores second start-up management information representing a correspondence among identification information on the at least one virtual computer, identification information on the logical storage area of the second storage medium storing the service program, and start-up authentication information for starting the at least one virtual computer;

the second storage medium includes a logical storage area generated by logically dividing a storage area of the second storage medium; and

the method further comprises:

a sixth step of extracting, by the first virtualization management module, the identification information on the first virtual computer included in a migration request, in a case of receiving the first the migration request to migrate the first virtual computer to the second computer;

a seventh step of referring, by the first virtualization management module, to the first start-up management information based on the extracted identification information on the first virtual computer to read the first service program from the logical storage area of the first storage medium;

an eighth step of transmitting, by the first virtualization management module, the identification information on the first virtual computer and the read first service program to the second computer;

a ninth step of obtaining, by the first virtualization management module, the encrypted first start-up authentication information from the first start-up management information based on the extracted identification information on the first virtual computer;

a tenth step of decrypting, by the first virtualization management module, the encrypted first start-up authentication information, and transmitting the decrypted first start-up authentication information to the second computer;

an eleventh step of deleting, by the first virtualization management module, from the first start-up management information, the correspondence among the identification information on the first virtual computer, the identification information on the logical storage area storing the first service program, and the encrypted first start-up authentication information;

a twelfth step of storing, by the second virtualization management module, the first service program in the logical storage area of the second storage medium and encrypting the decrypted first start-up authentication information, in a case of receiving the identification information on the first virtual computer, the first service program, and the decrypted first start-up authentication information; and

a thirteenth step of storing, by the second virtualization management module, the correspondence among the identification information on the first virtual computer, the identification information on the logical storage area storing the first service program, and the encrypted first start-up authentication information in the second start-up management information.

5. The method of managing a virtual computer according to claim **2**, wherein:

the plurality of computers include a second computer;

the second computer has a second processor, a second memory coupled to the second processor, a second network interface coupled to the second processor, and a second storage medium coupled to the second processor;

the second memory stores a program for realizing a second virtualization management module for generating the at least one virtual computer and managing the generated at least one virtual computer;

the second memory includes a second management storage area that is accessible only by the second virtualization management module and that stores second start-up management information representing a correspondence among identification information on the at least one virtual computer, identification information on the logical storage area of the second storage medium storing the service program, and start-up authentication information for starting the at least one virtual computer; and

the method further comprises:

a fourteenth step of extracting, by the first virtualization management module, the identification information on the first virtual computer included in a migration request, in a case of receiving the migration request to migrate the first virtual computer to the second computer;

a fifteenth step of referring, by the first virtualization management module, to the first start-up management information based on the extracted identification information on the first virtual computer to read the first service program from the logical storage area of the first storage medium;

a sixteenth step of transmitting, by the first virtualization management module, the identification information on the first virtual computer and the read first service program to the second computer;

a seventeenth step of deleting, by the first virtualization management module, from the first start-up management information, the correspondence among the identification information on the first virtual computer, the identification information on the logical storage area storing the first service program, and the encrypted first start-up authentication information;

an eighteenth step of storing, by the second virtualization management module, the first service program in the logical storage area of the second storage medium and generating second start-up authentication information for starting the first virtual computer, in a case of receiving the identification information on the first virtual computer and the first service program; and

a nineteenth step of storing, by the second virtualization management module, a correspondence among the identification information on the first virtual computer, the identification information on the logical storage area storing the first service program, and the generated second start-up authentication information in the second start-up management information.

6. The method of managing a virtual computer according to claim **1**, wherein the first step includes using the identification information on the first virtualization management module to generate the first start-up authentication information.

7. The method of managing a virtual computer according to claim **1**, wherein the first step further includes using the generated first authentication information to encrypt the logical storage area of the first storage medium storing the first service program.

8. A computer system, comprising a plurality of computers, wherein:

the plurality of computers include a first computer;

the first computer has a first processor, a first memory coupled to the first processor, a first network interface coupled to the first processor, and a first storage medium coupled to the first processor;

the first memory stores a program for realizing a first virtualization management module for generating at least one virtual computer by dividing a computer resource included in the computer and managing the at least one virtual computer;

the first memory includes a first management storage area that is accessible only by the first virtualization management module;

the first storage medium includes a logical storage area generated by logically dividing a storage area of the first storage medium;

the logical storage area stores a service program for executing a service on the at least one virtual computer;

the first management storage area stores first start-up management information representing a correspondence among identification information on the at least one virtual computer, identification information on the logical storage area storing the service program, and start-up authentication information for starting the at least one virtual computer;

the first computer has a first virtual computer for executing a first service program generated thereon; and

the first computer is configured to:

generate first start-up authentication information, in a case of receiving a generation command for the start-up authentication information for starting the first virtual computer;

store a correspondence among the identification information on the first virtual computer, the identification information on the logical storage area of the first storage medium storing the first service program, and the generated first start-up authentication information in the first start-up management information;

refer to the first start-up management information based on the identification information on the first virtual computer to determine whether or not the first start-up authentication information corresponding to the first virtual computer exists, in a case of receiving an start-up request for the first virtual computer including the identification information on the first virtual computer;

read the first service program from the logical storage area of the first storage medium, in a case where the first computer determines that the first start-up authentication information corresponding to the first virtual computer exists in the first start-up management information; and

start the first virtual computer by executing the read first service program.

9. The computer system according to claim **8**, wherein the first computer is configured to:

further encrypt the generated first start-up authentication information, in a case where the first computer generates the first start-up authentication information; and

store a correspondence among the identification information on the first virtual computer, the identification information on the logical storage area storing the first service program, and the encrypted first start-up authentication information in the first start-up management information.

10. The computer system according to claim **9**, wherein the first computer is further configured to:

determine whether the encrypted first start-up authentication information corresponding to the first virtual computer exists, in a case where the first computer determines whether the first start-up authentication information corresponding to the first virtual computer exists;

determine whether the encrypted first start-up authentication information is decryptable, in a case where the first computer determines that the encrypted first start-up authentication information corresponding to the first virtual computer exists; and

read the first service program from the logical storage area of the first storage medium, in a case where the first computer determines that the encrypted first start-up authentication information is decryptable.

11. The computer system according to claim **9**, wherein:

the plurality of computers include a second computer;

the second computer has a second processor, a second memory coupled to the second processor, a second network interface coupled to the second processor, and a second storage medium coupled to the second processor;

the second memory stores a program for realizing a second virtualization management module for generating the at least one virtual computer and managing the generated at least one virtual computer;

the second memory includes a second management storage area that is accessible only by the second virtualization management module and that stores second start-up management information representing a correspondence among identification information on the at least one virtual computer, identification information on the logical storage area storing the service program, and start-up authentication information for starting the at least one virtual computer;

the second storage medium includes a logical storage area generated by logically dividing a storage area of the second storage medium;

the first computer is further configured to:

extract the identification information on the first virtual computer included in a migration request, in a case of receiving the migration request to migrate the first virtual computer to the second computer;

refer to the first start-up management information based on the extracted identification information on the first virtual computer to read the first service program from the logical storage area of the first storage medium;

transmit the identification information on the first virtual computer and the read first service program to the second computer;

obtain the encrypted first start-up authentication information from the first start-up management information based on the extracted identification information on the first virtual computer;

decrypt the encrypted first start-up authentication information, and transmit the decrypted first start-up authentication information to the second computer; and

delete, from the first start-up management information, the correspondence among the identification information on the first virtual computer, the identification information on the logical storage area storing the first service program, and the encrypted first start-up authentication information; and

the second computer is configured to:

store the first service program in the logical storage area of the second storage medium and encrypt the decrypted first start-up authentication information, in a case of receiving the identification information on the first virtual computer, the first service program, and the decrypted first start-up authentication information; and

store a correspondence among the identification information on the first virtual computer, the identification information on the logical storage area storing the first service program, and the encrypted first start-up authentication information in the second start-up management information.

12. The computer system according to claim **9**, wherein:

the plurality of computers include a second computer;

the second computer has a second processor, a second memory coupled to the second processor, a second network interface coupled to the second processor, and a second storage medium coupled to the second processor;

the second memory stores a program for realizing a second virtualization management module for generating the at least one virtual computer and managing the generated at least one virtual computer;

the second memory includes a second management storage area that is accessible only by the second virtualization management module and that stores second start-up management information representing a correspondence among identification information on the at least one virtual computer, identification information on the logical storage area storing the service program, and start-up authentication information for starting the at least one virtual computer;

the first computer is configured to:

extract the identification information on the first virtual computer included in a migration request, in a case of receiving the migration request to migrate the first virtual computer to the second computer;

refer to the first start-up management information based on the extracted identification information on the first virtual computer to read the first service program from the logical storage area of the first storage medium;

transmit the identification information on the first virtual computer and the read first service program to the second computer; and

delete, from the first start-up management information, the correspondence among the identification information on the first virtual computer, the identification information on the logical storage area storing the first service program, and the encrypted first start-up authentication information; and

the second computer is configured to:

store the first service program in the logical storage area of the second storage medium and generate second start-up authentication information for starting the first virtual computer, in a case of receiving the identification information on the first virtual computer and the first service program; and

store a correspondence among the identification information on the first virtual computer, the identification information on the logical storage area storing the first service program, and the generated second start-up authentication information in the second start-up management information.

13. The computer system according to claim **8**, wherein the first computer further uses the identification information on the first virtualization management module to generate the first start-up authentication information, in a case where the first computer generates the first start-up authentication information.

14. The computer system according to claim **8**, wherein the first computer further uses the generated first start-up authentication information to encrypt the logical storage area of the first storage medium storing the first service program, in a case where the first computer generates the first start-up authentication information.

15. A computer, comprising:

a processor;

a memory coupled to the processor;

a network interface coupled to the processor; and

a storage medium coupled to the processor, wherein:

the memory stores a program for realizing a virtualization management module for generating at least one virtual computer by dividing a computer resource included in the computer and for managing the at least one virtual computer;

the memory includes a management storage area that is accessible only by the virtualization management module;

the storage medium includes a logical storage area generated by logically dividing a storage area of the storage medium;

the logical storage area stores a service program for executing a service on the at least one virtual computer;

the management storage area stores start-up management information representing a correspondence among identification information on the at least one virtual computer, identification information on the logical storage area storing the service program, and start-up authentication information for starting the at least one virtual computer; and

the computer is configured to:

generate the start-up authentication information, in a case of receiving a generation command for the start-up authentication information for starting the at least one virtual computer;

store a correspondence among identification information on the at least one virtual computer, identification information on the logical storage area of the storage medium storing the service program, and the generated start-up authentication information in the first start-up management information;

refer to the start-up management information based on the identification information on the at least one virtual computer to determine whether the start-up authentication information corresponding to the at least one virtual computer exists, in a case of receiving an start-up request for the at least one virtual computer including the identification information on the virtual computer;

read the service program from the logical storage area of the storage medium, in a case where the computer determines that the start-up authentication information corresponding to the at least one virtual computer exists in the start-up management information; and

start the at least one virtual computer by executing the read service program.

16. The computer according to claim **15**, wherein the computer is further configured to:

further encrypt the generated start-up authentication information, in a case where the computer generates the start-up authentication information; and

store a correspondence among the identification information on the at least one virtual computer, the identification information on the logical storage area storing the service program, and the encrypted start-up authentication information in the start-up management information.

17. The computer according to claim **16**, wherein the computer is further configured to:

determine whether the encrypted start-up authentication information corresponding to the at least one virtual computer exists, in a case where the computer determines whether the start-up authentication information corresponding to the at least one virtual computer exists;

determine whether the encrypted start-up authentication information is decryptable, in a case where the computer determines that the encrypted start-up authentication information corresponding to the at least one virtual computer exists; and

read the service program from the logical storage area of the storage medium, in a case where the computer determines that the encrypted start-up authentication information is decryptable.

18. The computer according to claim **16**, wherein the computer is further configured to:

extract the identification information on the at least one virtual computer included in a migration request, in a case of receiving the migration request to migrate the at least one virtual computer to another computer;

refer to the start-up management information based on the extracted identification information on the at least one virtual computer to read the service program from the logical storage area of the storage medium;

transmit the identification information on the at least one virtual computer and the read service program to the computer of a migration destination;

refer to the start-up management information based on the extracted identification information on the at least one virtual computer to obtain the encrypted start-up authentication information;

decrypt the encrypted start-up authentication information, and transmit the decrypted start-up authentication information to the computer of the migration destination;

delete, from the start-up management information, the correspondence among the identification information on the at least one virtual computer, the identification information on the logical storage area storing the service program, and the encrypted start-up authentication information;

store the service program in the logical storage area of the storage medium, and encrypt the decrypted start-up authentication information, in a case of receiving from the another computer the identification information on the at least one virtual computer, the service program, and the decrypted start-up authentication information; and

store a correspondence among the identification information on the at least one virtual computer, the identification information on the logical storage area storing the service program, and the encrypted start-up authentication information in the start-up management information.

19. The computer according to claim **16**, wherein the computer is further configured to:

extract the identification information on the at least one virtual computer included in a migration request, in a case of receiving the migration request to migrate the at least one virtual computer to another computer;

refer to the start-up management information based on the extracted identification information on the at least one virtual computer to read the service program from the logical storage area of the storage medium;

transmit the identification information on the at least one virtual computer and the read service program to the computer of a migration destination;

delete, from the start-up management information, the correspondence among the identification information on the at least one virtual computer, the identification information on the logical storage area storing the service program, and the encrypted start-up authentication information;

store the service program in the logical storage area of the storage medium and generate the start-up authentication information for starting the at least one virtual computer, in a case of receiving from the another computer the identification information on the at least one virtual computer and the service program; and

store a correspondence among the identification information on the at least one virtual computer, the identification information on the logical storage area storing the service program, and the generated start-up authentication information in the start-up management information.

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